

Swath Bathymetry Reveals Active Arc-Continent Collision Near Taiwan

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A joint French-Taiwanese cruise in May and June 1996 on the French research vessel *L'Atalante* has provided detailed structural images of the sea floor east and southwest of Taiwan. High quality swath bathymetry (see Figure 1) and seismic reflection profiles collected in southeastern and southwestern offshore areas near Taiwan will increase our understanding of how the Luzon Arc is deformed by its collision with the Chinese passive margin and how the Manila Trench connects with the deformation front on Taiwan. The data collected off the eastern coast of Taiwan will elucidate the nature of the plate boundary between the Ryukyu subduction zone and the Taiwan mountain belt and reveal the mode of back arc opening in the Southern Okinawa Trough. The investigations will contribute to understanding the processes of accretion of an arc to a continent prior to the ultimate collision between continents.

During the 24-day cruise, about 100,000 km² of swath bathymetry and backscattering image data and 5500 nautical miles of magnetic, gravity, and six-channel seismic reflection profiling data were collected (see insert of Figure 1).

The data also raised an interesting question about the interaction between the subducting Gagua Ridge and the Ryukyu active margin at 123°E.

The Southern Okinawa Trough

The Southern Okinawa Trough is a back arc basin located north of the Ryukyu island arc. A swath bathymetry map shows E-W trending normal faults associated with submarine volcanism in the southern part of the trough near Taiwan. These features represent the most recent phase of tectonic and magmatic activities. Spectacular meandering submarine channels trending ENE-WSW in the center of the Southern Okinawa Trough have been cut by recent normal faults. A prominent ENE-WSW trending structure, a probable strike-slip fault at the western end of the Southern Okinawa Trough, may connect to the Lishan Fault, which has been suggested to be a major suture zone on the island of Taiwan.

The Western End of the Ryukyu Arc-Trench Region

The northwestward subduction of the Philippine Sea plate underneath the Ryukyu Arc-

Trench system is highly oblique at its western end. The impingement of the Luzon volcanic arc with the passive Chinese continental margin terminated the Ryukyu subduction zone just off east Taiwan and caused deformation of the Ryukyu arc and forearc region here. Strong subsidence of both the westernmost part of the Ryukyu Arc and the sedimentary basins off Hualien, located in eastern Taiwan at the north end of the Coastal Range (the onland portion of the Luzon Arc), was confirmed.

The Yaeyama Ridge, which lies north of the Ryukyu Trench, is a typical accretionary wedge characterized by elongated ridges and thrusts. Swath bathymetry data suggest that the whole accretionary wedge migrates to the west along E-W and NW-SE strike-slip faults located at the rear of the wedge. At about 123°E, this accretionary wedge is indented over 20 km by the subducting Gagua Ridge. The forearc basins north of the Yaeyama Ridge have recorded episodes of uplift and subsidence caused by this ridge subduction. Several major submarine canyons, originating from both north and south of the Coastal Range, meet near the western end of the Ryukyu trench and flow to the east of the Gagua Ridge.

The Luzon Volcanic Arc

The arc-continent collision appears to be very active in the offshore part of the Coastal Range between Taitung and Hualien. The complex pattern of thrusts and probable strike-slip faults as revealed by the swath bathymetry and seismic reflection data is consistent with the clockwise rotation of crustal blocks of the arc, independently documented from onshore paleomagnetic studies.

South of Taitung, the detailed swath bathymetry data and seismic reflection profiles show that the forearc sediments of the Luzon subduction zone have undergone shortening and are progressively being thrust eastward over the Luzon Arc. Incipient collision between the Luzon Arc and the Chinese continental margin thus occurs south of the Longitudinal Valley Fault, which is the boundary between the Coastal Range and the Taiwan mountain belt.

Deformation Front of the Subduction-Collision Zone

The South China Sea oceanic crust is subducting eastward beneath the accretionary wedge along the Manila Trench south of Taiwan. Swath bathymetry and seismic reflection data collected off southwestern Taiwan provide details of two contrasting structural patterns that indicate the ongoing structural alteration from a "passive" to an "active" tectonic environment. Underneath a complex

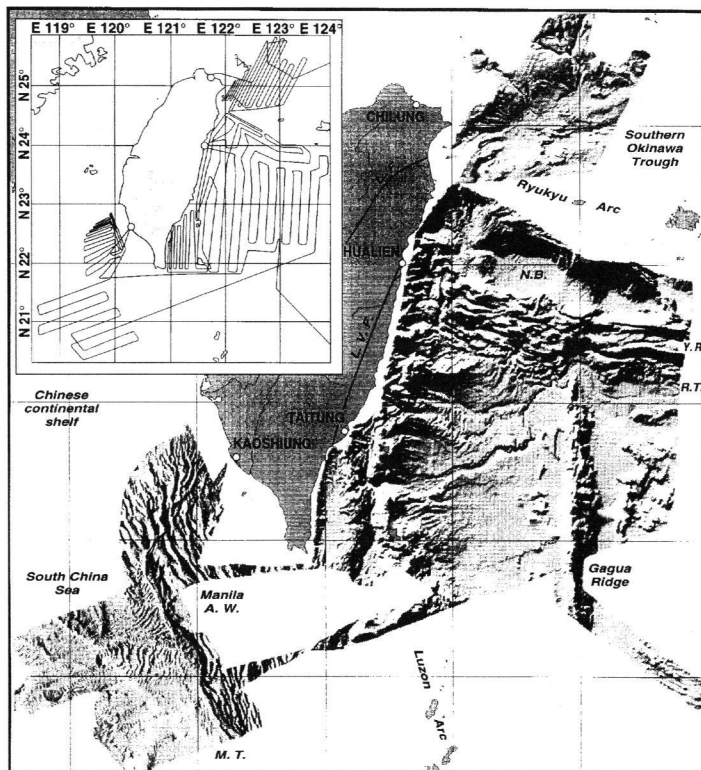


Fig. 1. Mosaic of shaded views of swath bathymetry acquired during the Active Collision in Taiwan (ACT) cruise, generated with Global Mapping Tool software. L.F. = Lishan Fault; L.V.F. = Longitudinal Valley Fault; Off-shore: N.B. = Nanao Basin; Y.R. = Yaeyama Ridge; R.T. = Ryukyu Trench; M.T. = Manila Trench; A.W. = accretionary wedge. Inset: R/V *L'Atalante* track lines during the ACT cruise (May 27-June 21, 1996).

submarine channel system, passive continental margin structures are observed in the Chinese continental shelf and slope region, whereas west-vergent imbricated fold and thrust sheets characterize the Manila accretionary wedge. These imbricated fold and thrust structures appear to connect northward to the active fold-and-thrust collision belt of southern Taiwan. The boundary between the "active" and "passive" structural patterns marks the location of the deformation front.

Acknowledgments

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the review of Mike Coffin.—*Serge E. Lallemand, Centre National de la Recherche Scientifique, Verrières-le-Buisson, France; Char-Shine Liu, Institute of Oceanography, National Taiwan University; and ACT cruise scientific team (Jacques Angelier; Jean-Yves Collot; Benoît Defontaine; Stéphane Dominguez; Marc Fournier; Shu-Kun Hsu; Jean-Pierre Le Formal; Shao-Yung Liu; Chia-Yu Lu; Jacques Malavieille; Philippe Schnurle; Jean-Claude Sibuet; Nicolas Thureau, and Fred Wang)*

GEOPHYSICISTS

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In Memoriam

Ramon R. Cabre died February 24, 1997, at age 74. He was a retired life member (Seismology) who joined AGU in 1962.

Tate Dalrymple died September 2, 1996, at age 92. He was a retired life member (Hydrology), who joined AGU in 1937.

Daniel D. Evans died recently at age 76. He was a retired life member (Hydrology) who had been a member since 1965.

Clayton H. Hardison died in August 1994, at age 83. He was a retired life member (Hydrology) who joined AGU in 1938.

Roderick A. Hutchinson died March 6, 1997, at age 50. He was a life member (Volcanology) who joined AGU in 1980.

Robert P. Meyer died April 10, 1997, at age 72. He had been a member (Seismology) since 1958.

Stephan Mueller died February 17, 1997, at age 66. He was an AGU Fellow (1995) (Seismology) who joined AGU in 1958.

Ned Ostenso died April 13, 1997, at age 67. He was a retired life member (Ocean Sciences) since 1953. Ostenso received the 1996 Waldo E.

Smith Medal for extraordinary service to geophysics.

Adolf K. Paul died recently at age 71. He had been a member (SPA—Aeronomy) since 1966.

Honors

Carol Arnosti has recently been chosen as a finalist for induction into the GTE Academic All-America Hall of Fame. Finalists were selected from a group of more than 100 Hall of Fame nominees and were chosen by a 90-member voting board representing the 1,800 College Sports Information Directors of America. Induction into this Hall of Fame is meant to honor former outstanding college student athletes who have attained high achievement in their professions and have made substantial contributions to their communities. Arnosti was ranked among the NCAA Division III rebounding leaders as a senior basketballer. Those efforts earned Arnosti a spot on the 1984 All-Midwest Conference team. She holds a doctorate in oceanography from the Massachusetts Institute of Technology and is currently a professor at the University of North Carolina.

AGU Fellow **Ghislain de Marsily**, professor of hydrology at the University Pierre et Marie Cu-

rie in Paris, has been elected as a Corresponding Member of the French Academy of Sciences.

American hydrologist **Peter Eagleson** was recently named as the winner of the 1997 Stockholm Water Prize, an international environmental award recognizing achievements in water conservation. Eagleson, who is a professor at the Massachusetts Institute of Technology, was awarded the \$150,000 prize for his achievement in hydrology. He was acknowledged for "single-handedly elevating hydrology to the level of a major scholarly science." The prize will be presented to Eagleson by Sweden's King Carl XVI Gustaf at a ceremony in Stockholm on August 14. Eagleson is an AGU Fellow and the recipient of several AGU honors: the Bowie Medal (1994), the Horton Medal (1988), and the Horton Award (1979).

Ernst Zinner recently received the J. Lawrence Smith Medal, which is given for investigations of meteoric bodies. Zinner, who is research professor of physics and of Earth and planetary sciences at the McDonnell Center for the Space Sciences at Washington University (St. Louis, Mo.), is honored for his "pioneering studies of the isotopic composition of circumstellar dust grains preserved in meteorites, opening a new window to the formation of the solar nebula." The award—a bronze medal and a \$20,000 cash prize—will be presented to him on April 28 at the National Academy of Sciences 134th annual meeting in Washington, D.C.

SECTION NEWS

ATMOSPHERIC SCIENCES



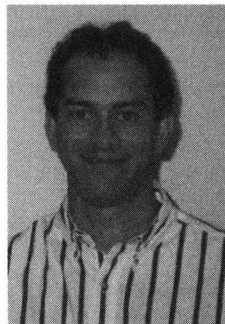
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Outstanding Student Papers

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Six presentations were named outstanding student papers in the Atmospheric Sciences Section at the 1996 Fall Meeting in San Francisco, California.

Brian S. Berland presented "Surface Sensitive Studies of ClONO₂ Hydrolysis on Ice." Berland graduated with a B.A. in chemistry from Carleton College in 1991. He then attended the University of Colorado at Boulder graduate program under the direction of professors Steven George and Margaret Tolbert, and recently he has received his Ph.D. in physical chemistry. His thesis focused on the role of heterogeneous chemistry in polar stratospheric ozone depletion. The optical constants of thin films representative of polar stratospheric clouds (PSCs) were measured using optical interfer-



ence and ultraviolet absorption. These measurements have been useful for the interpretation of field data to help determine the phase and composition of PSCs. In addition, surface sensitive techniques were used to study the mechanisms for heterogeneous chlorine activation on these surfaces.

Arlene G. Laing presented "The Global Distribution of Mesoscale Convective Complexes." Laing was born in St. Elizabeth, Jamaica, where she attended Glen Stuart Primary School and Hampton School. After completing a B.Sc. (Honors) in meteorology and computer science at the University of the West Indies (Barbados) in 1986, she was employed as a forecaster at the Norman Manley International Airport in Kingston providing aviation and general forecasts for Jamaica and the Cayman Islands as well as forecasts on Radio

