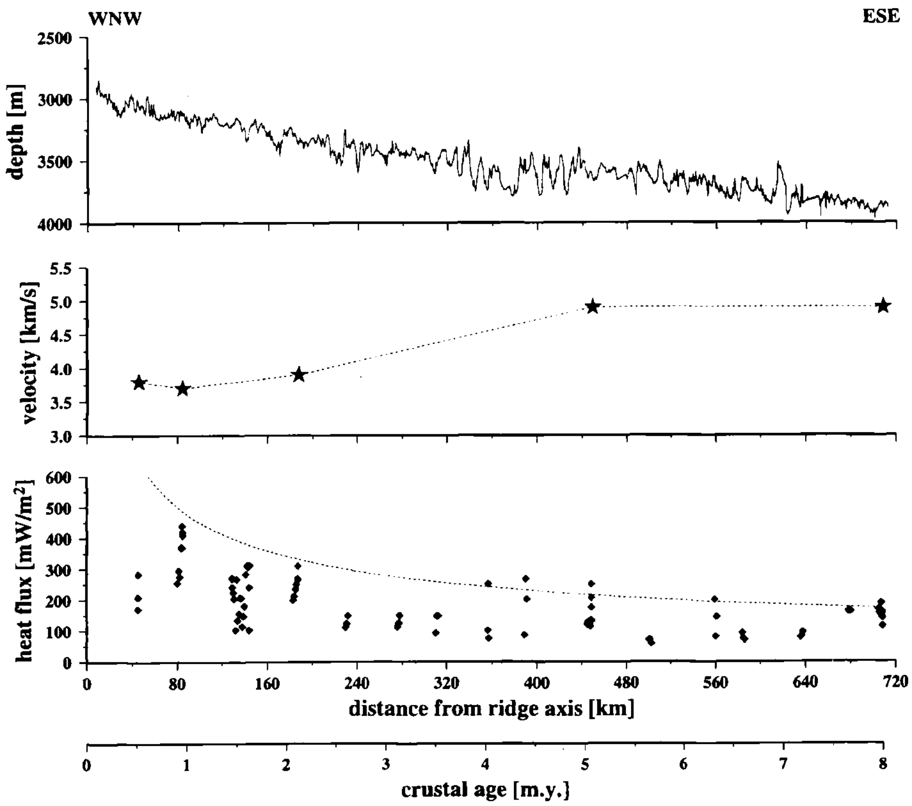

Fig. 1. (top) Topographic profile showing the seafloor structure of the east flank at the southern East Pacific Rise at 14°–16°S. (middle and bottom) A compilation of seismic velocities of upper oceanic crust and heat flow data from the cruise. The seismic velocities derived from seismic refraction experiments show a major increase from 3.9 to 4.9 km/s between 2 and 5 Ma. The heat flow data show a larger scatter in the crustal age range of 0.5–4 Ma with less scatter and smaller deviation from the plate cooling model in the range of 5–8 Ma.

ter among heat flow values obtained at a single station significantly decreases for crust older than 5 Ma and the heat flux approaches the trend of the plate cooling model at about 8 Ma (Figure 1). This suggests that hydrothermal flow of seawater into the oceanic crust becomes restricted in this area.

The primary evidence supporting hydrothermal circulation as an evolutionary process that affects seismic properties of the volcanic edifice (called layer 2A) and heat flux over millions of years was first presented 20 years ago. Seismic velocity likely increases because pore space and cracks fill with hydrothermal minerals as the crust ages. Near seafloor spreading centers, calculated heat flow values are well below those theoretically predicted by the plate cooling model, which only considers pure conductive heat dissipation. This may indicate that convection of seawater within permeable crust is removing a large amount of heat.

Hydrothermal circulation appears to be weakened or stopped by sediment blanketing. Away from spreading centers, where the observed heat flow approximately equals that predicted, hydrothermal heat transfer largely has ceased, and seawater is no longer available for hydrothermal alteration and precipitation of secondary minerals. It is at this stage that seismic velocity, being very sensitive to pore filling, reaches its maximum value. Because this process is controlled by sediment permeability, which depends on sediment composition, thickness, and diagenetic processes, published ages of this transition differ widely. Previous estimates reported values ranging from 1.5 Ma to about 80 Ma.

The Survey

The geophysical survey explored a 720-km-long tectonic corridor that intersects the East Pacific Rise at 14°S. Swath-mapping bathymetry, magnetics, seismic refraction, and reflection and heat flow data were acquired to investigate the evolution of oceanic crust at a "superfast" spreading ridge.

Five seismic refraction lines provided data of excellent quality. Compressional wave arrival times corresponding to ray paths entirely within layer 2A indicate velocities of 3.8, 3.7, 3.9, 4.9 and 4.9 km/s, for seafloor that is 0.5, 1.0, 2.0, 5.0 and 8.0 m.y. old, respectively. At fast spreading ridges, velocities on the ridge crest are typically less than 2.5 km/s. This implies that the layer 2A velocity increases rapidly near the ridge axis, doubles within 5 m.y. or less, and remains constant for older crust. This suggests that the hydrothermal circulation system has changed to a predominantly conductive system in relatively young crust.

This transition significantly affects the regional heat flow and is clearly reflected in data from the survey. To assess the regional decrease of heat flow with age as well as the known, highly variable local values, the researchers attempted to determine heat flow at age intervals of roughly 0.5 Ma. The values (60–470 mW/m^2) show a scatter by a factor of 3 at a single station, and almost all measurements lie below values predicted by the plate cooling model. However, the scatter decreases for ages greater than 5 Ma and approaches values predicted by the plate cooling model at about 8 Ma. In addition, even in the case of very high heat flux on 0.5-Ma-old crust and a sediment thickness of less than 20 m, no signs of diffuse fluid flux can be detected from the heat flow data.—*W. Weigel and I. Grevemeyer, Institute of Geophysics, University of Hamburg, Germany; N. Kaul and H. Villinger, Department of Earth Sciences, University of Bremen, Germany; T. Lüdmann and H. K. Wong, Institute of Biogeochemistry and Marine Chemistry, University of Hamburg, Germany*

Peat Bogs Reveal History of Atmospheric Deposition of Lead and Other Metals

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Records of atmospheric lead (Pb) deposition found in peat bogs, lake sediments, and polar ice are remarkably consistent. Each of these archives provides unequivocal evidence of significant anthropogenic Pb deposition extending back at least to Greek and Roman times. The "Roman Pb peak" has now been clearly identified in peat cores from northwestern Spain, Holland, Germany and Switzerland, and as far north as southern Sweden.

The Geological Institute of the University of Bern hosted a workshop to discuss findings about peat bog archives of atmospheric metal deposition from October 1 to 3, 1996. The workshop attracted 35 participants from 16 countries, with scientific specializations including analytical chemistry, archaeology, geochemistry, geophysics, limnology, mathematics, paleobotany, Quaternary geology, radiochemistry, and soil science. The diversity of participants underscores the importance of international, multidisciplinary collaboration in studying the peat bog records.

The validity of ^{210}Pb age-dating of peats was verified in cores from several bogs using ^{241}Am (americium) and Cannabis pollen as independent chronostratigraphic markers.

Not only was ^{210}Pb found to be a valuable tool for dating the past 150 years of peat accumulation, but the ^{210}Pb inventories agreed with the atmospheric fluxes to within 10%, indicating quantitative retention of this metal in the peat cores.

The peat bogs tell the story of lead production and its impact on the atmosphere. Following the decline of Rome, lead emissions were markedly lower during the medieval period, then increased rapidly during the industrial revolution. The greatest Pb fluxes occur in peats dating from the 1950s to the 1980s, following the introduction and widespread use of leaded gasoline. The decline in atmospheric Pb deposition since this time, mainly the result of efforts to eliminate leaded gasoline, should be encouraging to policymakers and legislators. However, the need to further reduce atmospheric metal emissions is illustrated by the Pb concentrations in recent peats and bog plants today, which are typically on the order of 100 times higher than the pre-anthropogenic values of 0.2 µg/g.

The consistency of continental-scale time series highlights the synchroneity of Pb fluxes on a global scale and indicates that all of these results should be compiled and integrated. Data on the isotopic composition of Pb (204, 206, 207, 208) in peats from Canada, Scotland, Sweden, and Switzerland promise to provide new information regarding the changing contributions of various sources of anthropogenic Pb to the air.

While many of the presentations at the workshop dealt primarily with Pb, some discussion centered on the record of pollution with respect to antimony, arsenic, cadmium, mercury, and tin. Much work is needed to determine which other metals, like Pb, are essentially immobile in peat cores and faithfully preserve the historical record of natural and anthropogenic atmospheric deposition.

Financial support for the workshop was provided by the Max and Elsa Beer-Brawand Foundation, the Swiss Academy of Natural Sciences, Zurich Insurance, and Berner Insurance.—*William Shotyk, Geological Institute, University of Bern, Switzerland; Stephen A. Norton, Department of Geological Sciences, University of Maine; and John G. Farmer, Department of Chemistry, University of Edinburgh, Scotland*

SECTION NEWS

HYDROLOGY

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Abriola Wins Outstanding Educator Award

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The Association for Women Geoscientists Foundation (AWGF) honored Linda M. Abriola as the 1996 Outstanding Educator on October 29 at the annual meeting of the Geological Society of America in Denver, Colorado. Abriola is a professor in the Department of Civil and Environmental Engineering at the University of Michigan, Ann Arbor, and a former secretary of AGU's Hydrology Section. By their selection of Abriola as the 1996 Outstanding Educator, AWGF recognized her excellence as a researcher, teacher, and mentor to aspiring women scientists.

Linda Abriola earned four degrees in civil engineering: a B.S. degree from Drexel University, and an M.S., an M.A., and a Ph.D. from Princeton University. In 1984, she joined the faculty at the University of Michigan, where she received tenure in 1990 and advanced to full professor in 1996.

A world-renowned researcher in the field of groundwater contamination and remediation, she has focused on the development and refinement of multiphase flow models for the transport of nonaqueous phase liquid contaminants in groundwater systems. Her early mathematical modeling work has been the foundation for all subsequent work in this area. Through interdisciplinary collaboration with other investigators, Linda Abriola is currently using experiments and mathematical modeling to develop alternative technologies for aquifer remediation.

She teaches undergraduate courses in hydrology and fluid mechanics, as well as graduate courses in numerical modeling and theoretical aspects of subsurface flow. Abriola provides undergraduates with practical experience by requiring the design of a remediation scheme for an actual groundwater contamination site. While challenging students to excel, she also makes a strong effort to get to know them and solicits their feedback.

Besides her research and teaching, Abriola offers her time and support to the University of Michigan Women in Science and Engineering (WISE) Program. She has participated in many panel discussions on career opportunities in engineering. During the "Summerscience" program, Abriola provided middle school girls with advice, stressing the importance of taking mathematics and science in high school. She has also served as a research mentor to undergraduate women through the Sarah Parker Scholars program.

In addition to serving in elected positions for the Association of Environmental Engineering Professors and AGU's Hydrology Section, Abriola has served on the editorial boards of several scientific journals and has also serverd on committees of the AGU, the National Science Foundation, the National Research Council, the U.S. Environmental Protection Agency, Waterloo Center for Groundwater Research, and the Western Region Hazardous Substance Research Center. This AWGF award follows receipt of other awards—the NSF Faculty Award for Women Scientists and Engineers (1991), the University of Michigan College of Engineering Research Excellence Award (1994), and being selected as the 1996 Distinguished Darcy Lecturer by the National Groundwater Association.–*Janet Bauder Thornburg, Houston, Tex.*