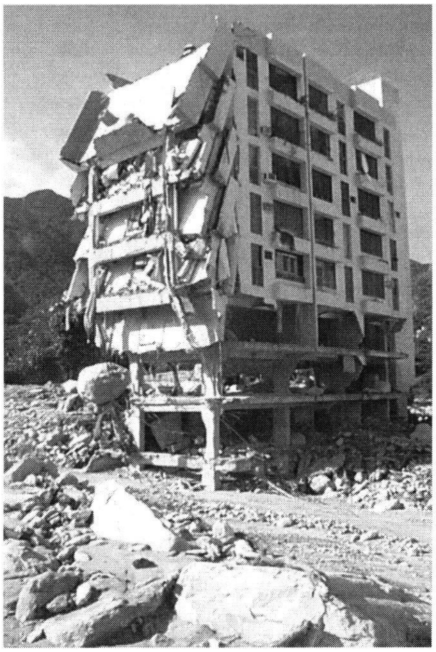

Fig. 2. Debris flow damage to an apartment building in Caraballeda, Vargas, Venezuela, occurred in January 2000. Debris flows passed through the first two stories of this building.

the structure. Examination of deposits exposed on terraces and along the banks of river channels in Vargas reveals a record of prehistoric floods and debris flows as well.

The Vargas Debris Flow-Flash Flood Disaster

Most of the December 1999 landslides initiated as thin soil slides or debris slides—soil with pieces of rock—as indicated by shallow sliding surfaces within soil or weathered, foliated, and jointed rock. With the addition of more water from either the hill slopes or the channels, these slides of loose soil and rock liquefied into debris flows. Most landslides occurred within the top 0.5–2.0 m of soil or weathered schist or gneiss [*Wieczorek et al.*, 2001]. Some smaller slides coalesced to denude larger sections of hillsides. Stratigraphic sequences exposed in main scarps indicated some reactivation of previous landslides. Debris flows and other types of landslides numbered in the thousands on steep hill slopes in the coastal mountain range and coalesced into massive debris flows that moved rapidly down steep narrow canyons. Stream-channel gradients in these catchments range from 20% to 50% (11° to 27°); on the canyon floor, gradients average 5° to 10° in reaches 3–6 km upstream of their alluvial fans. In the several kilometers south, or upstream of the alluvial fans, channel slopes average 4° to 6° and decrease to 2° to 4° across the fans before reaching the Caribbean Sea.

Flash floods, hyper-concentrated flows, and debris flows occurred in the canyons and alluvial fans of most of the several dozen small catchments (watershed areas on the order of 10–30 km^2) that drain the coastal mountain range. Residents with homes on the alluvial fans described multiple high stream flows and debris flows that began late on the night of December 15 and continued until the afternoon of December 16. Although the alluvial fans showed evidence of massive debris flows, most also contained well-stratified flood deposits, indicating that both flood and debris flow processes were common. A combination of debris flows that transported massive boulders and flash floods carrying extremely high sediment loads were the principal agents of destruction. On virtually every alluvial fan along the Vargas coastline, rivers incised new channels into fan surfaces to depths of several meters, and massive amounts of new sediment were disgorged upon fan surfaces in quantities of up to 15 metric tonnes per square meter. Sediment size ranged from clay and sand to numerous boulders as large as 10 m in diameter (Figure 2). Sediment and debris, including massive boulders, were deposited up to several meters thick across large sections of alluvial fans.

A combination of climatologic and geologic factors make alluvial fans highly susceptible to episodic debris flows and flash floods. In Vargas, the extremely steep, tectonically active Cordillera de la Costa forms the boundary with a tropical sea. Easterly trade winds and storms can force moist air masses upslope and precipitate large rainfall volumes, creating conditions for high-magnitude debris flows and flash floods.

The example discussed in this article demonstrates the potential for extreme loss of life and property damage where a large population occupies an alluvial fan. The possibility for an event of comparable magnitude exists in other parts of the world where extensive development has encroached on alluvial fans. Without careful planning of human settlements, the impacts of these types of disasters are likely to increase in the future.

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The Great Kanto Earthquake and F. Scott Fitzgerald

PAGE 577

How many recall the following striking sentence from *The Great Gatsby* by F. Scott Fitzgerald, which appears on the second page of the novel, where Fitzgerald first introduces Gatsby? "If personality is an unbroken series of successful gestures, then there was something gorgeous about him, some heightened sensitivity to the promises of life, as if he were related to one of those intricate machines that register earthquakes ten thousand miles away."

This line may have failed to focus our attention when we first read the book in our younger days. Now, however, as a Japanese seismologist and an American geophysicist (and student of Japanese culture), we would be greatly remiss for failing to take greater note of this statement. Indeed, as *The Great Gatsby* was published in 1925, it occurred to us that the earthquake Fitzgerald might have been thinking of was the Great Kanto earthquake, which occurred on September 1, 1923 and devastated the Tokyo metropolitan area.

The Great Gatsby is a story about people in Long Island, New York. The distance between the epicenter of the Kanto earthquake and

> **Japanese Earthquake Recorded Across the World From Hawaii to London by Observatory Instruments**
>
> HILO, Hawaii, Sept. 1 (Associated Press).—The seismograph at Kealakekua at 7 o'clock last night registered a severe distant earthquake.
>
> Sampans in the harbor were warned to beware of a tidal wave. Reports received here said a slight tidal wave was noticed at the Island of Puna, off the coast of Ecuador. No damage was reported.
>
> BERKELEY, Cal., Sept. 1.—The seismograph of the University of California recorded a "very severe" earthquake starting at 10 minutes and 16 seconds after 7 o'clock last night and lasting for three hours and fifty minutes. The indicated distance was 5,400 miles and the point of origin in the region between Tokio and Osaka, Japan.
>
> WASHINGTON, Sept. 1.—An earthquake described as extremely severe and continuing nearly five hours last night and early today was recorded on the Georgetown University seismograph. Beginning at 10:12 P. M., the disturbance reached a maximum intensity between 10:30 and 11 o'clock, and lasted until 3 A. M. Director Tondorf of the observatory estimated the centre of the disturbance at about 6,300 miles from Washington.
>
> WEST BROMWICH, England, Sept. 1 (Associated Press).—An exceptionally severe earthquake shock was recorded at the observatory here at about 4:11 this morning.
>
> The seismograph indicated that the origin of the tremors was 5,500 miles distant from here. The movement was sufficiently strong to ring an alarm bell and disarrange the mechanism of the recording instrument.

Long Island is about 10,000 km. From on-line biographical materials on Fitzgerald compiled by the Thomas Cooper Library of the University of South Carolina in honor of the 1996 centenary of his birth (http://www.sc.edu/fitzgerald/chronology.html), we know that he was in New York when the Great Kanto earthquake struck. A subsequent chronology is as follows:

- Mid-October 1922–April 1924: Fitzgeralds rent house at 6 Gateway Drive in Great Neck, Long Island.
- Mid-April 1924: Fitzgeralds sail for France.
- May 1924: Fitzgeralds visit Paris, then leave for The Riviera; stop at Grimm's Park Hotel in Hyares and settle in June at Villa Marie Valescure, St. Raphael.
- Summer–Autumn 1924: FSF writes *The Great Gatsby*.

The front page of *The New York Times* of September 2, 1923, carried a headline about the earthquake, along with several stories about various aspects of the disaster. On page 2, a boxed item with the following title appeared: "Japanese Earthquake Recorded Across the World From Hawaii to London by Observatory Instruments." This item tells how the earthquake was recorded on seismographs in Hilo, Hawaii; Berkeley, Calif.; Washington, D.C.; and West Bromwich, England. It seems likely that Fitzgerald read this item that Sunday morning, and that this was the inspiration for his striking sentence.

It is startling to reflect that seismographs were installed all over the world 80 years ago and that their recordings, reported in the next morning's newspaper, became an inspiration for a great novelist. We cannot help admiring our predecessors, and perhaps providing such inspiration to the world beyond the geophysical community should be considered one of our challenges today as well. Indeed, it might be of general interest to investigate the various roles played by geophysical events in the literary realm. At least it was inspiring for us to uncover the likely link between the Great Kanto Earthquake and F. Scott Fitzgerald.

Acknowledgments

The book *Honyaku Yawa* by Haruki Murakami and Motoyuki Shibata was our inspiration for examining *The Great Gatsby* anew.

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BOOK REVIEWS

Earth's Climate: Past and Future

PAGE 576

William F. Ruddiman
W.H. Freeman and Company, New York, 465 pp., paperback, ISBN 0-7167-3741-8, 2001, $76.70.

Given the prominence of global climate change issues in the United States and abroad, it is surprising that there has not been an introductory-level textbook that adequately addresses the Earth's climate system in a systematic, easy to read, multidisciplinary manner. *Earth's Climate: Past and Future* by W. F. Ruddiman is exactly that: an excellent introductory textbook covering the basic science and the paradigms that govern our current understanding of Earth's climate system. In his opening remarks, Ruddiman states his goal that the book make climate science interesting and intelligible to all students, especially to non-science majors taking an upper-division science course. Ruddiman successfully tackles this goal.

Ruddiman chose a natural structure for the book: by time scale. After an introduction to Earth's present climate system, he begins with long-term climate change associated with tectonics and telescopes down to millennial and historic climate change, finishing with an evaluation of future climate change. As Ruddiman writes in the preface, "the main reason [for this structure] is simply that this is the way the history of Earth's climate actually developed, so it seems the most natural way to tell the story." From the small detail to the overall structure, the book is carefully and purposefully written to focus on the key elements of the science, pointing out rich complexities in concepts such as feedback loops, while managing not to get lost in details. Particularly effective is Ruddiman's technique of allowing the science to unfold as a story of how scientists have posed and tested hypotheses for the causes of climate change.

The textbook is impressive in its comprehensive coverage of the subject. The first section provides a framework for evaluating past and future changes, including discussions of the components within Earth's climate system and their interactions, the climate archives available to scientists, how the records are dated, and how one integrates such data into models of climate systems.