

Bulletin of the Seismological Society of America

Vol. 77

June 1987

No. 3

THE 1983 BORAH PEAK, IDAHO, EARTHQUAKE

PREFACE TO COLLECTION OF PAPERS ON THE 1983 BORAH PEAK, IDAHO, EARTHQUAKE

BY R. C. BUCKNAM AND ROSS. S. STEIN

This issue of the *Bulletin* contains 10 papers focused on research related to the 28 October 1983, $M = 7$ Borah Peak, Idaho, earthquake. The investigations represent a cross section of the 40 research papers presented at a workshop on the surface faulting, seismology, geodesy, hydrology, and geology of the earthquake and its setting (Stein and Bucknam, 1985). The earthquake generated intense scientific interest, partly because of the long time interval between large earthquakes in the Great Basin. There have been only six large (magnitude ≥ 7) historic shocks in the Great Basin, and it had been 24 yr since the most recent of these large shocks when the Borah Peak earthquake occurred. During those 24 yr, numerous new concepts have been developed about the seismological, geological, and geophysical character of normal faulting earthquakes, and the Borah Peak event provided a rare opportunity to test those concepts as well as to add to the small but valuable base of data on large Great Basin earthquakes.

Although the historic record of large earthquakes in the Great Basin is sparse, the late Quaternary geologic record provides a greatly expanded picture of long-term spatial and temporal patterns of earthquakes in that region. Study of the geologic record of those earthquakes has been an important element in the development of new ideas on the nature of fault rupture and the timing of earthquakes along major fault zones, and the late Quaternary faulting at the foot of Borah Peak had been studied from that point of view a decade ago. The 35-km-long surface rupture that was formed by the 1983 earthquake mimicked a preexisting Holocene fault scarp along the west side of the Lost River Range with astounding precision. The scarp had been excavated and examined in the previous studies and was found to have been created by a prehistoric slip event displacing a 15,000-yr-old alluvial surface. When combined, the two earthquakes yield an average slip rate of about 0.2 to 0.3 mm/yr during the past 15,000 yr for the section of the 150-km-long Lost River Range that has the greatest total structural relief. In contrast, the southernmost section of the range, which has an average slip rate of about 0.1 mm/yr during the past 100,000 to 150,000 yr, has about one-half the total structural relief of the section along the 1983 rupture, and the most recent earthquake there occurred about 30,000 yr ago (Scott *et al.*, 1985).

Field studies of geometry of fault zones and the characteristics of prehistoric ruptures along them can provide estimates of the rupture length and slip to be expected from future events along those faults. For example, slip on the fault in the 1983 Borah Peak earthquake did not occur along a random section but was confined to an interval of the Lost River Range marked by distinctive geometric and geomorphic properties of the fault trace. The southern end of the 1983 rupture

corresponds to a 50° bend in the trend of the Lost River fault, and the northern end of the fault splays into two branches with markedly diminished prehistoric and 1983-event scarp heights. Geological, seismological, and geodetic studies of the largest historic normal-faulting earthquake sequences in the Great Basin at Dixie Valley-Fairview Peak, Nevada; Hebgen Lake, Montana; and Borah Peak, Idaho (Doser, 1985, 1986; Stein and Barrientos, 1985; Doser and Smith, 1986) show the events to be characterized by rather uniform fault depth (about 15 km) and dip (40° to 70°), which suggests that the fault width of $M \geq 7$ events tend to be around 20 km. Thus the fault slip, length, and width can be judged for assessment of the maximum seismic moment and hence magnitude of future events along major normal fault zones in the Great Basin. Predicting the time of earthquakes with recurrence periods measured in thousands to tens of thousands of years is a much more tenacious problem, particularly given the dearth of documented preseismic ground deformation or precursory seismicity for Great Basin events. Historic seismicity data gave no clue of the impending Borah Peak earthquake: although the shock lies within the diffuse Intermountain Seismic Belt, no event of $M \geq 3.5$ had occurred near the epicentral region during the past two decades of monitoring (Dewey, 1987). Looking ahead from Borah Peak, the historically unbroken and heavily populated Wasatch frontal fault looms large. The Borah Peak shock has highlighted the fundamental similarities between the Lost River fault in Idaho and the Wasatch fault to the south in Utah. Both fault zones appear to be typified by 2-m slip events. Thus, the investigation of the Borah Peak event, in concert with continuing studies of the Wasatch fault scarp morphology, slip history, and segmentation, offers rare clues to assess the likely pattern of occurrence of future Wasatch fault events. It nevertheless remains uncertain whether the next great earthquake along the Wasatch fault will also strike the fault segment with the highest slip rate, as the Borah Peak shock appears to have done along the Lost River Range, or whether it will occur along a segment that has a very old scarp (a "gap-filling" earthquake). The answer to this riddle will continue to elude us until it becomes known how faithfully slip at the surface records slip at seismic depths, and whether variations in slip rate on adjacent scarp segments can persist for tens of thousands of years.

The collection of papers in this issue of the *Bulletin* provides a broad view of the research data on this important earthquake. Other relevant papers have already been published elsewhere, and those that we are aware of are listed below.

OTHER PUBLISHED REPORTS ON THE BORAH PEAK EARTHQUAKE

- Adham, S. A. and B. Ballif (1983). The Borah Peak, Idaho earthquake of October 28, 1983—Buildings and schools, *Earthquake Spectra* **2**, 169–182.
- Boatwright, J. (1985). Characteristics of the aftershock sequence of the Borah Peak, Idaho, earthquake determined from digital recordings of the events, *Bull. Seism. Soc. Am.* **75**, 1265–1284.
- Crone, A. J. and M. N. Machette (1984). Surface faulting accompanying the Borah Peak earthquake, central Idaho, *Geology* **12**, 664–667.
- Doser, D. I. and R. B. Smith (1985). Source parameters of the 28 October 1983 Borah Peak, Idaho earthquake from body wave analysis, *Bull. Seism. Soc. Am.* **75**, 1041–1051.
- Eppich, E. S. (1983). The Borah Peak, Idaho earthquake of October 28, 1983—Lifelines, *Earthquake Spectra* **2**, 225–237.
- Guenzler, R. C. and V. W. Gorman (1983). The Borah Peak, Idaho earthquake of October 28, 1983—Industrial facilities and equipment at INEL, *Earthquake Spectra* **2**, 183–203.
- Jackson, S. M. and J. Boatwright (1985). The Borah Peak, Idaho earthquake of October 28, 1983—Strong ground motion, *Earthquake Spectra* **2**, 51–69.
- Keefer, D. K., R. C. Wilson, E. L. Harp, and E. W. Lips (1985). The Borah Peak, Idaho earthquake of October 28, 1983—Landslides, *Earthquake Spectra* **2**, 91–125.

- Nigg, J. M. (1985). The Borah Peak, Idaho earthquake of October 28, 1983—Societal response, *Earthquake Spectra* **2**, 17–21.
- Pelton, J., C. W. Meissner, and K. Smith (1984). An eyewitness account of the fault scarp formation, *Bull. Seism. Soc. Am.* **74**, 1083–1089.
- Reitherman, R. (1983). The Borah Peak, Idaho earthquake of October 28, 1983—Performance of unreinforced masonry buildings in Mackay, Idaho, *Earthquake Spectra* **2**, 205–224.
- Scott, W. E., K. L. Pierce, and M. H. Hait, Jr. (1985). Quaternary tectonic setting of the 1983 Borah Peak earthquake, central Idaho, *Bull. Seism. Soc. Am.* **75**, 1053–1066.
- Stein, R. S. and S. E. Barrientos (1985). Planar high-angle faulting in the Basin and Range: geodetic analysis of the 1983 Borah Peak, Idaho, earthquake, *J. Geophys. Res.* **90**, 11355–11366.
- Stein, R. S. and R. C. Bucknam (Editors) (1985). Proceedings of workshop XXVII on the Borah Peak, Idaho, earthquake, *U.S. Geol. Surv., Open-File Rept. 85-290*, 686 pp.
- Stover, C. W. (1985). The Borah Peak, Idaho earthquake of October 28, 1983—Isoseismal map and intensity distribution, *Earthquake Spectra* **2**, 11–16.
- Taylor, C. L., K. M. Cline, W. D. Page, and D. P. Schwartz (1985). The Borah Peak, Idaho earthquake of October 28, 1983—Surface faulting and other phenomena, *Earthquake Spectra* **2**, 23–49.
- Waag, C. J. and T. G. Lane (1985). The Borah Peak, Idaho earthquake of October 28, 1983—Structural control of ground water eruptions and sediment boil formation in the Chilly Buttes area, *Earthquake Spectra* **2**, 151–168.
- Wallace, R. E. (1984). Eyewitness account of surface faulting during the earthquake of 28 October 1983, Borah Peak, Idaho, *Bull. Seism. Soc. Am.* **74**, 1091–1094.
- Ward, S. N. and S. E. Barrientos (1986). An inversion for slip distribution and fault shape from geodetic observations of the 1983, Borah Peak, Idaho, earthquake, *J. Geophys. Res.* **91**, 4909–4919.
- Whitehead, R. L., R. W. Harper, and H. G. Sisco (1985). Hydrologic changes associated with the October 28, 1983, Idaho earthquake, *Pure Appl. Geophys.* **122**, 280–293.
- Wood, S. H., C. Wurts, T. Lane, N. Ballenger, M. Shaleen, and D. Totorica (1985). The Borah Peak, Idaho earthquake of October 28, 1983—Hydrologic effects, *Earthquake Spectra* **2**, 127–150.
- Youd, T. L., E. L. Harp, D. K. Keefer, and R. C. Wilson (1985). The Borah Peak, Idaho earthquake of October 28, 1983—Liquefaction, *Earthquake Spectra* **2**, 71–89.

REFERENCES

- Dewey, J. W. (1987). Instrumental seismicity of central Idaho, *Bull. Seism. Soc. Am.* **77**, 819–836.
- Doser, D. I. (1985). Source parameters and faulting processes of the 1959 Hebgen Lake, Montana, earthquake sequence, *J. Geophys. Res.* **90**, 4537–4555.
- Doser, D. I. (1986). Earthquake processes in the Rainbow Mountain-Fairview Peak-Dixie Valley, Nevada, region 1954–1959, *J. Geophys. Res.* **91**, 12572–12586.
- Doser, D. I. and R. B. Smith (1985). Source parameters of the 28 October 1983, Borah Peak, Idaho, earthquake from body wave analysis, *Bull. Seism. Soc. Am.* **75**, 1041–1051.
- Scott, W. E., K. L. Pierce, and M. H. Hait, Jr. (1985). Quaternary tectonic setting of the 1983 Borah Peak earthquake, central Idaho, *Bull. Seism. Soc. Am.* **75**, 1053–1066.
- Stein, R. S. and S. E. Barrientos (1985). Planar high-angle faulting in the Basin and Range: Geodetic analysis of the 1983 Borah Peak, Idaho, earthquake, *J. Geophys. Res.* **90**, 11,355–11,366.

U.S. GEOLOGICAL SURVEY
 BOX 25046, MS 966
 FEDERAL CENTER
 DENVER, COLORADO 80225 (R.C.B.)

U.S. GEOLOGICAL SURVEY
 MS 977
 345 MIDDLEFIELD ROAD
 MENLO PARK, CALIFORNIA 94025 (R.S.S.)

Manuscript received 4 February 1987

