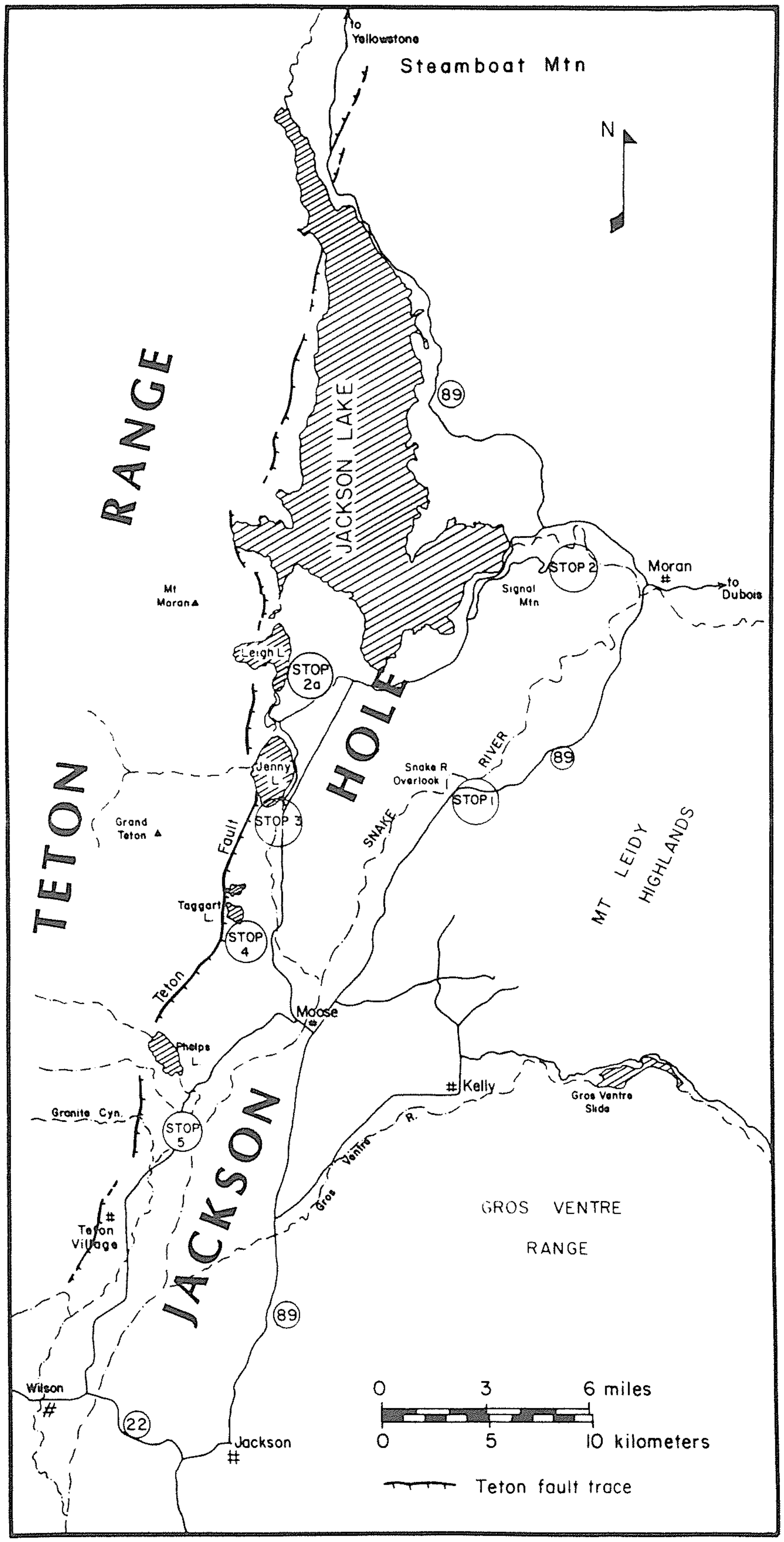


Figure 1. Trip route and stop locations, field trip no. 6. Map of Teton fault trace is taken from detailed mapping by Susong and others (1987) and data from the U.S. Bureau of Reclamation studies (Gilbert and others, 1983; Ostenaa, 1988).

Field trip no. 6

NEOTECTONICS AND STRUCTURAL EVOLUTION OF THE TETON FAULT

Robert B. Smith and John O.D. Byrd
Department of Geology and Geophysics
University of Utah
Salt Lake City, Utah 84112

and

David D. Susong[1]
U.S. Geological Survey
Cheyenne, Wyoming 82003

Trip Summary (see Figure 1)

Stop 1. Snake River Overlook at Deadman Bar
Stop 2. South Signal Mountain Overlook
2a. Cathedral Group turnout
Stop 3. Jenny Lake
Stop 4. South Taggart Lake moraine (optional)
Stop 5. Granite Canyon

Introduction

The Teton normal fault extends 44 miles (70 km) north-south along the east side of the Teton Range and is the principal structure responsible for the spectacular topographic relief of the range (**Figure 2**). The Teton fault has been mapped by previous workers: (1) at a regional scale (Love and Reed, 1971; Love and others, in press), and (2) in detail at several locations along the fault trace by Gilbert and others (1983) during an evaluation of the seismic safety of the Jackson Lake dam site. In 1987, a general earthquake hazard evaluation of the entire Teton fault zone (Smith, 1988) and surrounding region was initiated by the University of Utah that included detailed mapping and scarp profiling of the Teton fault by Susong and others (1987) and Smith (1988). In 1988 and 1989, additional components of the study were added: (1) a 14-mile-long (22.5-km) east-west 1st-order level line (Byrd and others, 1988) was established across the Teton fault to assess contemporary deformation, (2) a paleomagnetic evaluation of the Huckleberry Ridge Tuff was made to determine rotation about horizontal and vertical axes and related deformation associated with the Teton fault during the past 2 million years, and (3) a trench was excavated across the Teton fault to determine the age of faulting.

This field trip (**Figure 1**) will discuss the results from these studies and others of our colleagues with five stops that provide an overview of: (1) the geology of the Tetons and Jackson Hole as it relates to the Teton fault, (2) the extent and magnitude of Quaternary displacements on the Teton fault, (3) the regional earthquake setting and related earthquake hazards, (4) evidence of paleo-earthquake activity and neotectonic deformation, and (5) the recurrence times of large paleo-earthquakes on the fault.

The occurrence of two large historic earthquakes, the M_L 7.5, 1959, Hebgen Lake, Montana, and the M_S 7.3, 1983 Borah Peak, Idaho, events on large normal faults surrounding the Snake River Plain (**Figure 3**) has focused attention on the hypothesis that the Yellowstone hotspot, and its track, the Snake River Plain (SRP) volcanic system, has influenced the present-day

[1]Formerly at the University of Utah.

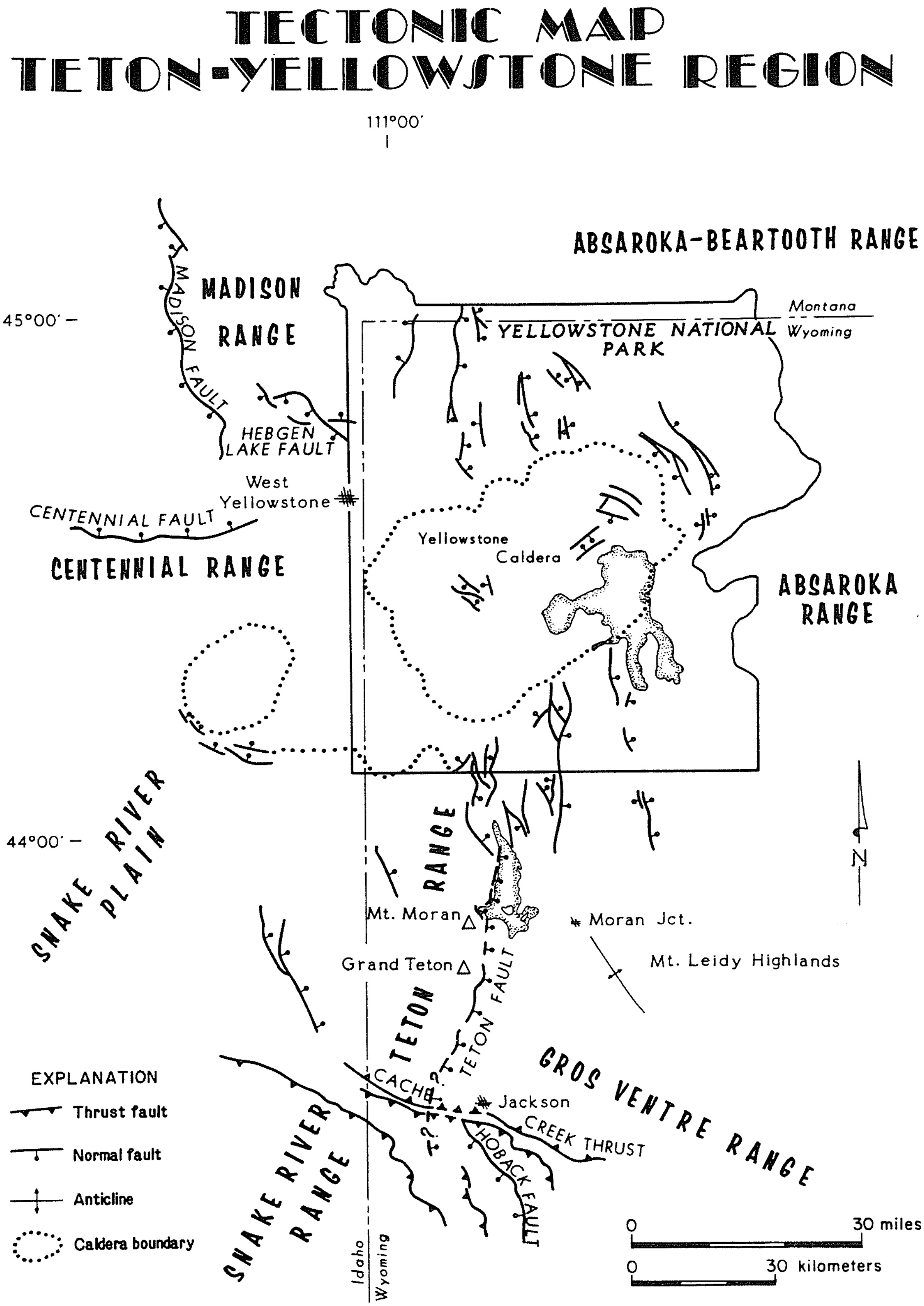


Figure 2. Regional tectonic index map of the Teton Range and Jackson Hole area.

seismotectonics of the central Intermountain seismic belt, including the Teton region (Smith, 1988). These earthquakes and several other large events of the Intermountain region and the Yellowstone Plateau (**Figure 4**) are part of a V-shaped pattern of epicenters surrounding the aseismic Snake River Plain (Smith and others, 1984). Lithospheric subsidence, both perpendicular and parallel to the Snake River Plain, suggests that thermal contraction and/or stress-field relaxation related to passage of the Yellowstone hotspot has strongly influenced the distribution of past events and the overall earthquake potential of the region (Smith and others, 1990).

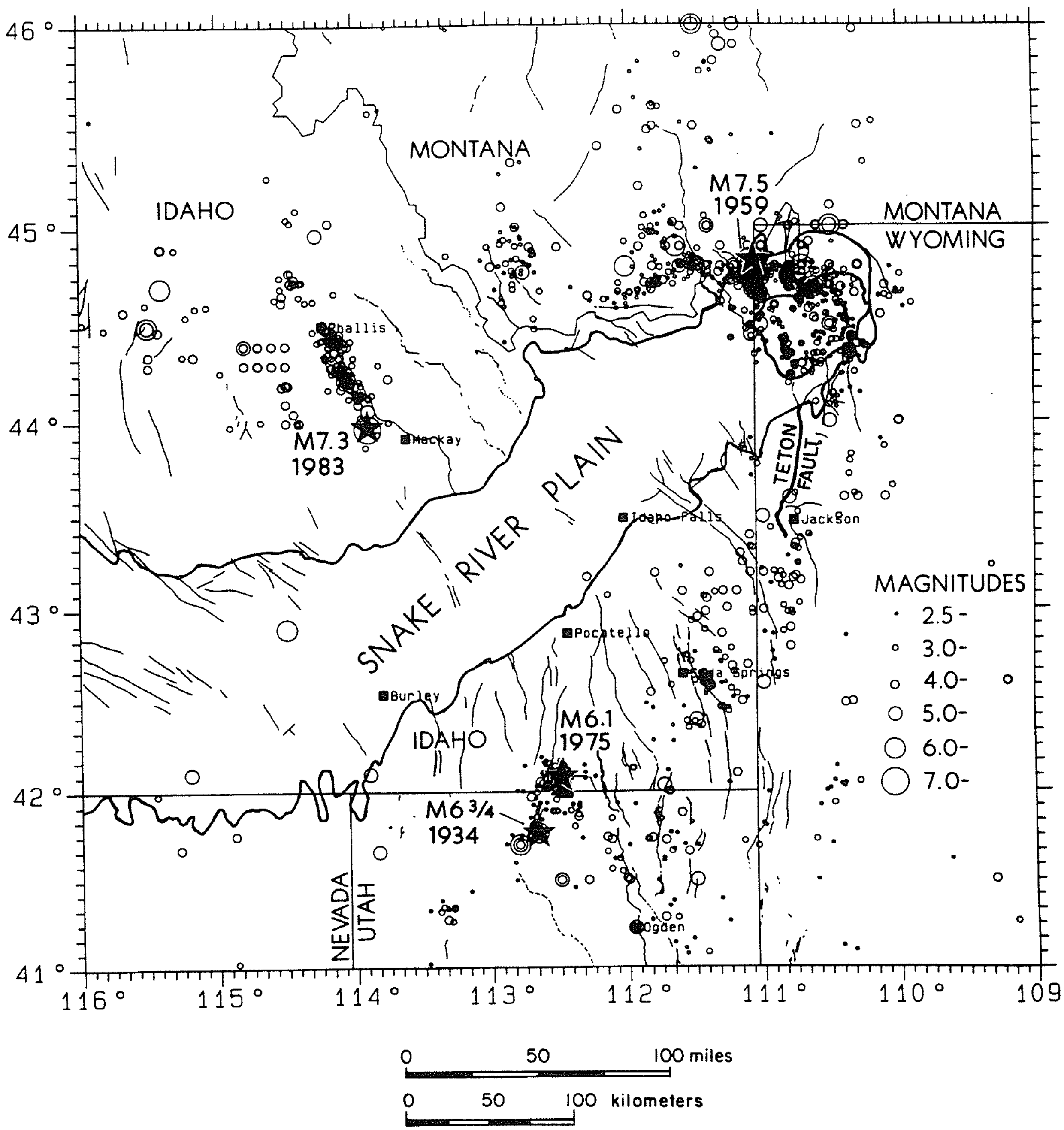


Figure 3. Seismicity map of the Snake River Plain, Yellowstone, and Teton region (map taken from Smith, 1988). Earthquake data are principally for the 1900 to 1985 period with a minimum magnitude cutoff of 3.5. Stars indicate the epicenters of the M_s 7.3, 1983 Borah Peak, Idaho, and the 1959, M_L 7.5 Hebgen Lake, Montana, earthquakes. The Yellowstone-Snake River Plain volcanic system is characterized by bimodal, basalt-rhyolite rocks. Blackened areas indicate numerous overlapping earthquakes.

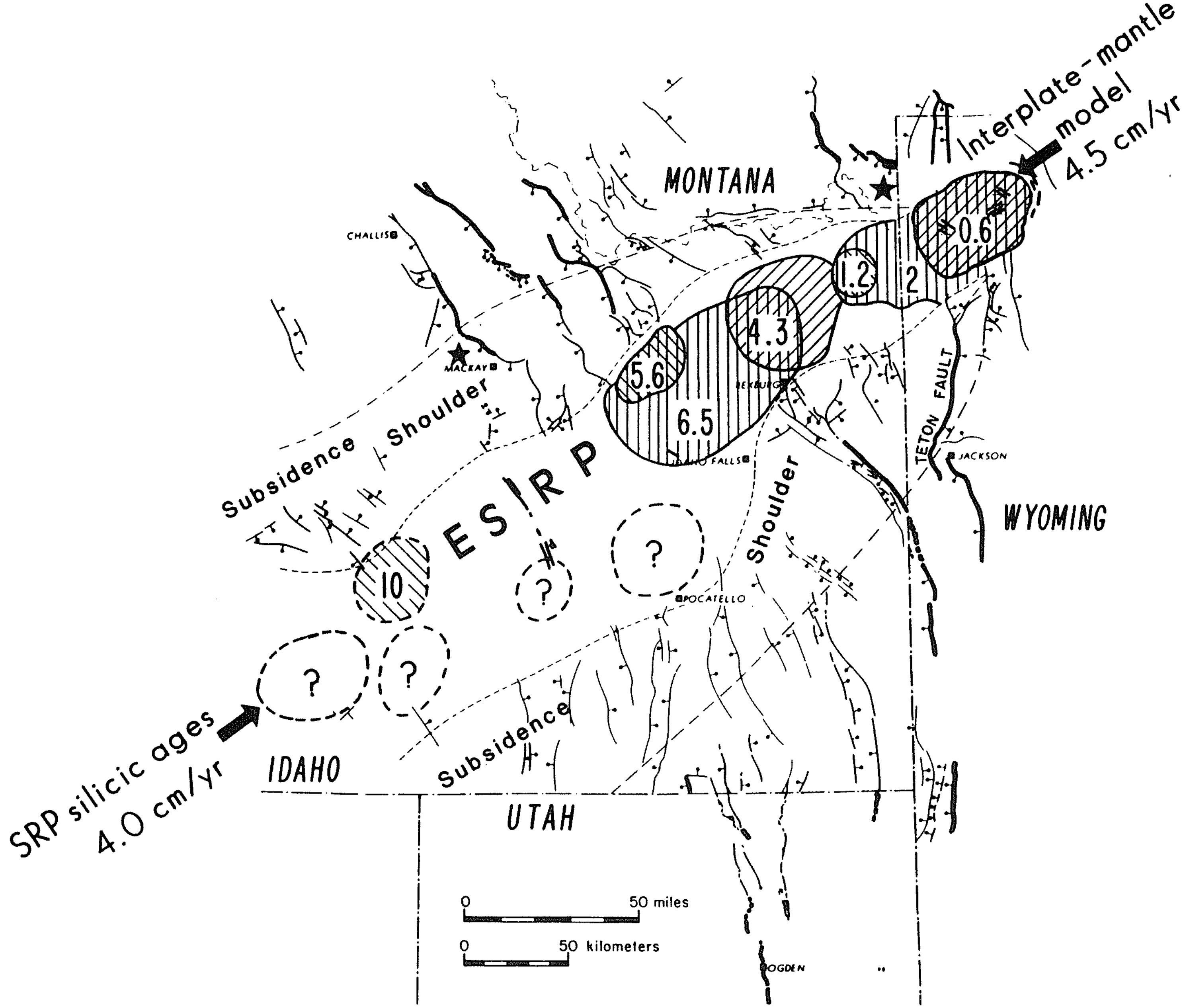


Figure 4. Distribution of late Cenozoic normal faults and boundary of hypothesized subsidence shoulder associated with Yellowstone hotspot lithospheric deformation (map modified from Smith and others, 1984). ESRP = eastern Snake River Plain. Arrow at Yellowstone is the direction of motion of the North American plate with respect to Yellowstone hotspot with a relative velocity of ~3.5 mm/yr. Fine-dashed line = boundary of Snake River Plain volcanic province and coarse-dashed line = boundary of hypothesized lithospheric subsidence shoulder. Stars indicate the epicenters of the M_s 7.3, 1983 Borah Peak, Idaho, and the 1959, M_L 7.5 Hebgen Lake, Montana, earthquakes. Heavy lines = normal faults with Holocene displacements, light lines = normal faults with Quaternary faulting, but lacking Holocene displacements. Caldera boundaries are indicated by vertical line pattern and heavy dashes. Outlines of calderas, with ages in millions of years, where known, are shown along the ESRP. Caldera locations and ages from Morgan and others (1984) and Mel Kuntz (personal communication, 1988).

The Teton fault zone is located on the southeastern edge of an active seismic zone in the Yellowstone area, and southeast of a seismically quiescent "shoulder" that trends subparallel to the aseismic Snake River Plain (**Figures 3** and 4). The Teton area is also located southeast of an area of late Cenozoic normal faulting, where evidence of Holocene displacement is absent, and northwest of an area marked by Holocene faulting and surface rupture (Smith and others, 1990). These observations lead Smith and others (1984) to suggest that the thermal-mechanical effects of the Yellowstone hotspot may extend laterally away from the SRP in a roughly V-shaped pattern, parallel to the two major seismic zones surrounding the SRP, and may have influenced the earthquake potential of the Teton fault zone.

Stop descriptions

Stop 1. Snake River Overlook at Deadman Bar

Subsidence of the valley in the vicinity of Wilson, at the southern end of Jackson Hole, was first recognized by Love and Montagne (1956), who showed that two parallel tributaries at the base of the range were "lower in elevation than the Snake River in positions at right angles to the flow of the river." The important observation at the first stop on the field trip is to view (to the west) the westward tilt of the valley floor adjacent to the Teton fault. This area of subsidence, adjacent to the fault, has been measured by two detailed topographic profiles [measured by 1st-order leveling and electronic distance measuring (EDM)] that revealed up to 85 feet (26 m) of subsidence at Jenny Lake, over a zone 2.3 miles (3.7 km) wide east of the Teton fault, relative to the top of the uppermost terrace level west of the Snake River Overlook.

Stop 2. South Signal Mountain Overlook

This stop will emphasize the tectonics and regional geophysics of the area. Tectonically (**Figure 2**), the Teton Range is located at the northeastern side of the Basin-Range province, east of the Snake River Plain volcanic province, south of the Quaternary Yellowstone volcanic plateau, and on the northern margin of the Wyoming-Idaho Overthrust Belt. The Teton range is a westward tilted, Precambrian-cored fault block composed of intensely deformed and metamorphosed Precambrian gneiss, diabase, and quartz monzonite (Reed, 1973). West dipping Paleozoic sedimentary and Quaternary volcanic rocks cover the core of the range and extend across its northern and southern ends (Love and others, in press; Lageson, 1987). The structural evolution of the Teton Range has been influenced by four major post-Paleozoic events:

(1) Mesozoic to early Tertiary, east-west compression accompanying development of the Wyoming-Idaho Overthrust Belt province; several Laramide structures, such as the Spread Creek anticline, are visible east of Signal Mountain, and the northern edge of the Overthrust Belt, the Cache Creek and Jackson thrusts, can be seen on the horizon to the south;

(2) The late Tertiary Basin-Range epeirogeny and crustal extension that produced the Teton fault with its subsequent 3.7 to 6.9 miles (6 to 11 km) of stratigraphic displacement and the resultant topography of Jackson Hole;

(3) Late Cenozoic volcanism and crustal deformation associated with the nearby Snake River Plain volcanic system during passage of the Yellowstone hotspot with subordinate silicic volcanism found throughout the area north of Jackson Hole; and

(4) Extensive silicic volcanism associated with the Quaternary Huckleberry Ridge tuff of the Yellowstone volcanic plateau that caps the north end of the Teton Range and is seen in scattered outcrops throughout the northern end of the valley.

From the south Signal Mountain Overlook, one can view the spectacular topography of the Teton Range that attains a maximum relief of 7,200 feet (2.2 km) adjacent to the 13,770-foot-high (4,197-m) peak of the Grand Teton. The precipitous topographic relief on the east side of the range was produced principally by movement on the Teton fault (**Figure 2**) and is the focus of the field trip.

It is interesting to note that the area of highest relief along the Teton Range does not coincide with the north-south trending drainage boundary, in the middle of the range, but is located approximately 2.5 miles (4 km) east of the drainage boundary, where it is marked by a line connecting the high peaks at the front of the range. This pattern is suggestive of a high uplift rate, eg. a rapid westward tilt rate, of the footwall block of the Teton fault that exceeds the normal rate of erosion and weathering of the mountain front.

The Teton fault zone is marked by an estimated 3.7 to 6.9 miles (6 to 11 km) of total stratigraphic displacement (Byrd and others, 1988) that has taken place over the past 7 to 9 million years (Love and Reed, 1971). Quaternary fault scarps, up to 157 feet (48 m) high, are present along 34 miles (55 km) of the 44-mile-length (70-km) of the Teton fault and are well preserved in Pinedale aged (~15,000 years old) moraines, younger fluvial deposits, and alluvial material. Components of left-lateral offset are also evident in the south-central part of the fault zone.

Based upon 17 EDM profiles and topographic surveys of the Teton fault scarp and extensive detailed geologic mapping (**Figure 5**), Quaternary surface offsets across the fault are shown to increase from an average of 33 feet (10 m) at the northern and southern ends of the fault to a maximum of 98 feet (30 m) in the central portion of the fault zone, defining, in part, three fault segments; the south, central, and north (Susong and others, 1987; Smith, 1988). Ostenaa (1988) evaluated segmentation of the Teton fault on the basis of Bureau of Reclamation studies and suggested two segments; one including the southern and central segments and a northern segment the same as Susong and others (1987) and Smith (1988). The lateral variation in surface offset along the fault also coincides with the changes in topographic relief (highest in the central segment) along the mountain front, suggesting a causal relationship between the areas of highest topography and the areas of greatest fault activity.

The southern end of the Teton fault appears to terminate near its intersection with older Overthrust Belt structures at the Cache Creek and Jackson thrusts (**Figure 2**). The fault may extend south of Wilson, although no Quaternary scarps are preserved there. The boundary between the southern and central segments is postulated to coincide with a 23° counterclockwise change in strike of the fault south of Taggart Lake. This segment boundary is also marked by an increase in average surface offset (greater in the central segment) and evidence for a left lateral component of offset on the central segment that is not seen to the south.

The boundary between the northern and central segments (**Figure 1**) is postulated to occur near Moran Bay, where the middle segment of the Teton fault terminates and may splay into a zone of highly fractured and jointed Precambrian bedrock north of Moran Canyon. The northern segment of the fault appears to begin 1.25 miles (2 km) east, on the north side of Moran Bay, and extend north to Wilcox Point where it may separate into multiple faults. One of these northernmost faults appears to extend northward beneath Jackson Lake and has been identified in the Steamboat Mountain area on the east side of the lake. Other branches of the fault may extend northward along the Snake River to the area near the boundary of Yellowstone National Park.

However, local earthquake data collected by nearby seismograph networks suggest a pronounced zone of small background earthquakes that extends northward from the Teton fault beneath the Pitchstone Plateau of Yellowstone National Park and may reflect activity on the ancient Teton fault, now covered by the Quaternary Yellowstone volcanics. Offset segments of the Teton fault are thought to step right (eastward) across the area north of Jackson Lake and several other normal faults appear to take up the displacement northeastward into the Yellowstone Plateau.

Deformation in the hanging wall of the northern part of the Teton fault is also suggested by the 10° to 20° westward tilt of Tertiary-Quaternary tuffs that are exposed at Signal Mountain. However, it is important to note that a significant portion of the deformation of the Signal Mountain block may be due, in part, to its location in the footwall of an unexposed normal fault on the east side of the mountain.

Paleomagnetic survey

In 1988 and 1989, personnel from the University of Utah and the University of New Mexico collected paleomagnetic samples at 67 sites in the Huckleberry Ridge Tuff throughout the footwall and hanging wall blocks of the Teton fault to evaluate the magnitude and extent of post 2 million year rotations about vertical and horizontal axes associated with the deformation along the structure. The sampling campaigns included collection at closely spaced sites along an east-west traverse extending from the western flank of the Tetons, across the northern end of the range, and continuing across the northern Jackson Hole region including Signal Mountain.

Seismic reflection survey of Jackson Lake

Seismic reflection surveys of Jackson Lake were made by the University of Utah in 1974 (Smith and others, in preparation). The reflection profiles show a pronounced Quaternary basin, with up to 660 feet (200 m) of lacustrine deposits, associated with the main north-south lake basin. This basin was associated with

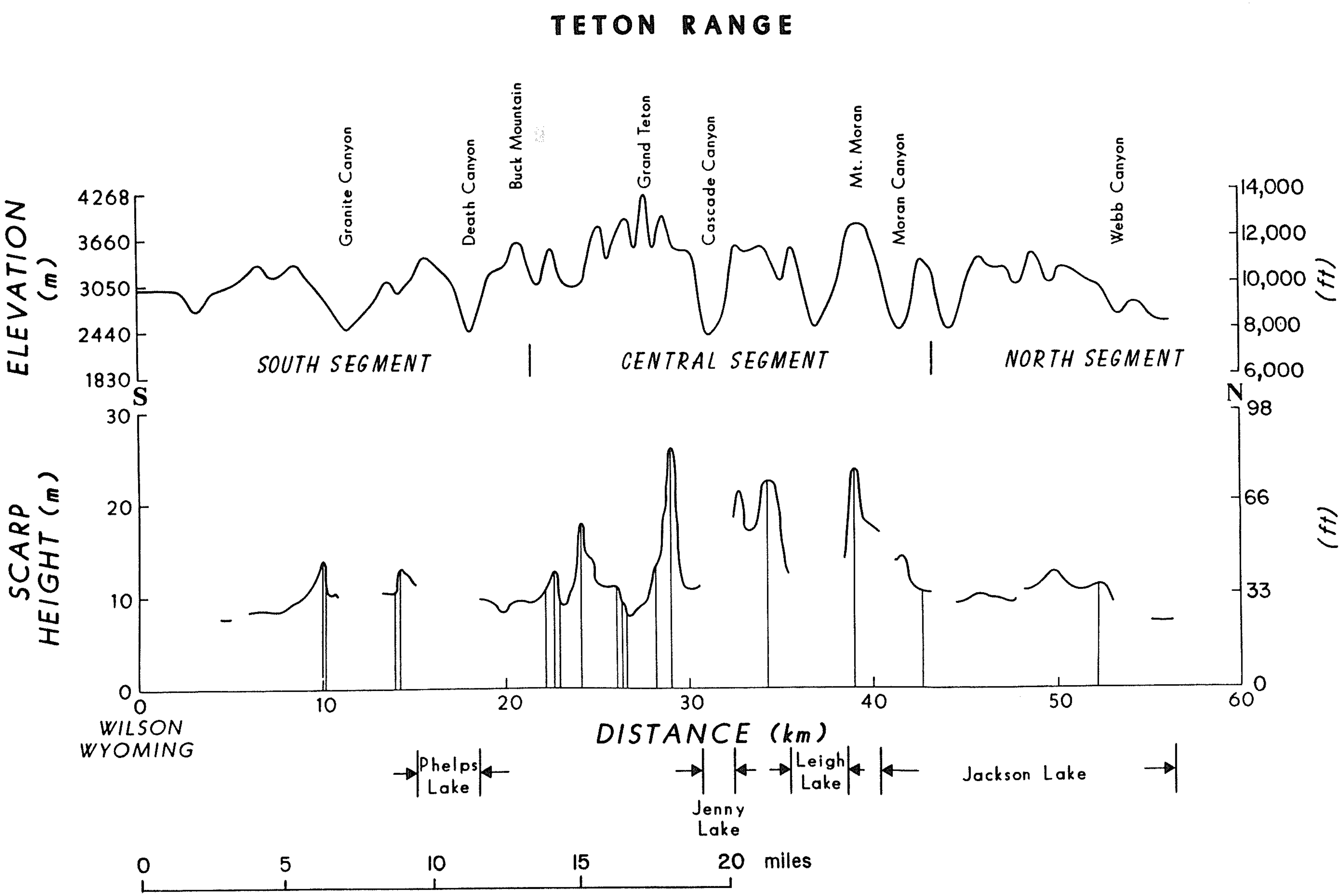


Figure 5. Topographic relief of the footwall block and Quaternary surface offsets across the Teton fault. Fault offsets were measured by EDM profiles at locations marked by vertical lines. Segment boundaries are discussed in text.

the ancestral Jackson Lake, which probably filled a glacially scoured depression adjacent to the Teton fault at the base of the range. Notably, no evidence of faulting or related tectonic deformation of the Quaternary sediments was seen on the seismic profiles. However, several episodes of sedimentation and subaerial exposure can be interpreted from the seismic profiles in the flat-lying main lake basin sediments.

In contrast, a more complex pattern of variable east-to-west dipping Quaternary lake sediments can be seen on the profiles in Jackson Lake west of Signal Mountain. These patterns are probably sedimentary features that result from scouring and deposition due to the advance and retreat of glaciers in and around Signal Mountain, as interpreted by Ken Pierce of the U.S. Geological Survey (personal communication).

Seismicity

Historic earthquake data (**Figures 3** and **6**) show that the the Teton fault zone is in a state of relative seismic quiescence and is surrounded by a dispersed earthquake activity associated with the Intermountain seismic belt. Local earthquake surveys by the University of Utah and the U.S. Bureau of Reclamation show a diffuse pattern of background seismicity in the Mt. Leidy Highlands, the area east of Moran, the southern Teton Range, and the Gros Ventre Range. However, the evidence for extensive Quaternary displacements and the contemporary seismic quiescence of the Teton fault led Smith (1988) to postulate a seismic gap for the Teton fault (**Figure 6**). If this hypothesis is true, the fault may be locked and the seismicity gap may be expected to "fill in" with a large earthquake in the future to accommodate the regional crustal deformation. Alternate explanations for the seismic quiescence of the Teton fault include: (1) the general seismicity of the area may be migrating eastward into the Gros Ventre and surrounding mountains, (2) the period of historical observation may not be sufficient to make a reasonable estimate of the long-term seismicity rate, and (3) the area surrounding the fault zone may not now be storing potential energy for some unknown reason.

By comparison, the region surrounding the Teton region has experienced some of the largest earthquakes in historic time, including the magnitude M_L 7.5, 1959 Hebgen Lake earthquake (the largest historic earthquake in the Rocky Mountains) 56 miles (90 km) from the Teton fault, and earthquakes as large as M_s 6.1 and extensive swarms associated with the Yellowstone caldera that begin just 6.2 miles (10 km) north of the Teton fault. In addition, the M_s 7.3, 1983 Borah Peak, Idaho, earthquake occurred on the Lost River fault on the west side of the Snake River Plain in a tectonic setting similar to that of the Teton area. These two M > 7 events are considered as hypothetical working models for the type and style of large earthquakes that one could expect in the Jackson Hole area. Similar ground deformation, ground accelerations, and surface rupture properties for these events could be postulated for the Teton fault. These analogues are useful to assess the expected hazards, ground deformation, and effects on structures and facilities in the Jackson Hole area during a major earthquake.

Stop 2a. Cathedral Group Turnout

From this location (**Figure 1**), a view to the west of one of the largest Quaternary fault scarps of the Teton fault is seen on the west side of String Lake. Here, a 112-foot (34-m) fault scarp in glacial debris and alluvial material marks the fault trace. Note the scalloped shape of the fault scarp above String Lake that is suggestive of a large landslide. At this location the scarp is on strike and is contiguous with the main fault trace. We believe that most of the scarp height is due to displacement on the fault, but there may be some additional displacement amplification by slumping and landslides.

Another notable feature seen at this stop is the subsidence of a north-south trending area, extending 2.3 miles (3.7 km) east from String Lake. On the basis of EDM profiling, we have documented 95 feet (29 m) of subsidence relative to the crest of the Jackson Lake glacial outwash. This zone of subsidence parallels the range front and confines the streams and lakes to the pronounced southward drainage direction from Leigh Lake to String Lake to Jenny Lake. This area at the south end of Leigh Lake marks the northernmost extent of regional subsidence adjacent to the Teton fault.

Stop 3. Jenny Lake

On the west side of Cottonwood Creek, at the outlet of Jenny Lake, a bench mark of a 1st-order level line established and surveyed in 1988 by the University of Utah and the University of California, Santa Barbara can be seen. Fifty bench marks were established and surveyed to assess contemporary deformation that may be associated with pre-, co-, and post-seismic movement of the Teton fault. This east-west profile of accurately measured bench marks extends 14 miles (22.5 km) from within the footwall of the Teton fault (in the center of the Teton Range) eastward at approximately 1,640 ft (500 m) intervals, crossing the Teton fault west of Jenny Lake, around the north end of

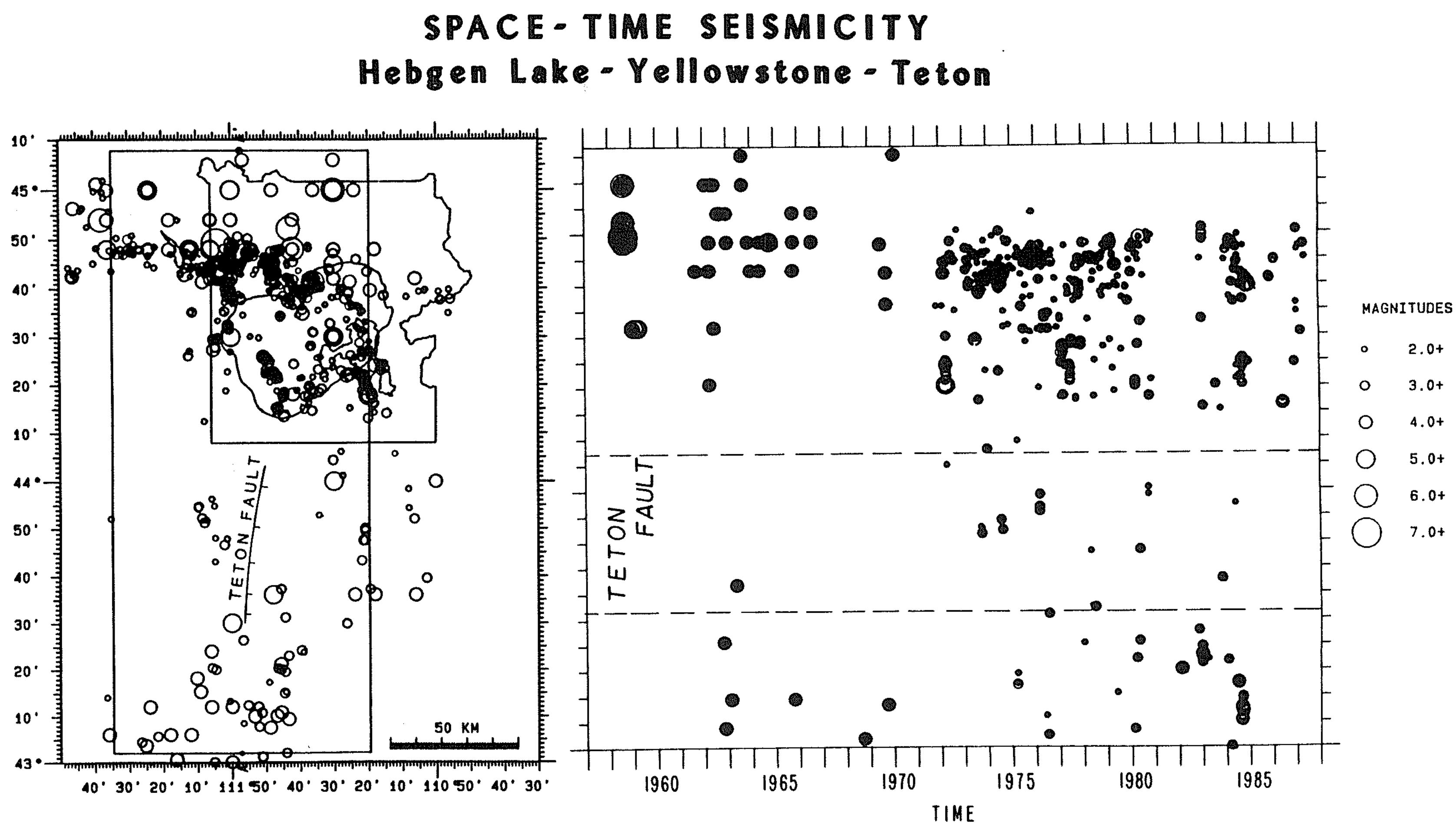


Figure 6. Time-space plot of seismicity surrounding the Teton fault zone for the period 1959 to 1987, showing the general seismic quiescence of the Teton fault at the M > 3 level. Figure taken from Smith (1988). Blackened areas indicate numerous overlapping earthquakes.

Timbered Island to the Snake River near Deadman Bar, well into the hanging wall. Preliminary results from the 1989 initial re-leveling survey show that the footwall block, the Teton Range, subsided 1.27×10^{-4} inches $\pm 1.78 \times 10^{-5}$ inches (5 mm ± 0.7 mm) relative to the valley floor, the hanging wall—notably in the opposite directions of the expected pre-seismic deformation for a normal fault.

In addition, three of the leveling benchmarks were observed by Global Satellite Positioning (GPS) instruments in 1989 and tied to the regional Yellowstone GPS network. This newly developed method, useful to assess contemporary tectonics, will provide a tie for determining vertical and lateral deformation within a global framework, and can be used to determine the regional extensional strain rates of the Jackson Hole region with respect to the North American plate.

Walk westward 1.25 miles (2 km) from the west side of Cottonwood Creek (Stop 3), along the upper horse trail, to observe the Teton fault south of Jenny Lake where it crosses the top of the south Jenny Lake moraine. At this site, approximately 82 feet (25 m) of vertical displacement along the north-south trending Teton fault, with several meters of displacement along a westward facing antithetic fault, can be seen in the Pinedale-age moraine. In addition, there is a suggestion here for a component of left-lateral offset across the main fault, similar to that observed in the lateral moraine on the south side of Taggart Lake, 6.2 miles (10 km) to the south; however the complex pattern of moraine terminations and the oblique offset due to the faulting make this interpretation somewhat equivocal. At Jenny Lake, the fault extends northward along a steep escarpment and then continues beneath the west side of the lake. To the south, the fault is exposed at the base of a steep slope west of the Moose Ponds. It continues 1.25 miles (2 km) southward, crossing a large alluvial fan above Lupine Meadows, and splays into two or possibly three strands within the fan, where a total of 98 feet (30 m) of fault offset has been measured.

The close association of the scarp with the Moose Ponds suggests that back-tilt along the fault may play a role in damming intermittent streams and forming a sag pond. Young debris flows from the Lupine Meadows alluvial fan are also deposited near the front of the pond, suggesting that they too contribute to the obstruction of stream flow and formation of the ponds.

Fault modeling

Jenny Lake is a good place to review the data and possible reasons for the subsidence and range-front capture of southward flowing streams adjacent to the Teton fault. Westward back-tilting of the valley floor due to Quaternary displacement on the Teton fault is a possible explanation for the observed subsidence and stream flow pattern. Other explanations suggest that the apparent westward tilt of the valley may be a result of westward flow along pre-exisiting drainages exiting from the terminal moraines in the vicinity of Jackson Lake, and/or aggradation of sediments deposited by the Snake and Gros Ventre rivers. However, we believe that the juxtaposition of the westward tilted valley against the active Teton normal fault is a natural consequence of slip and hanging-wall subsidence associated with displacement on the fault. Similar patterns of hanging-wall deformation, subsidence, and tilting have been observed in association with several large normal faulting earthquakes in the western U.S., eg. the M_L 7.5, 1959, Hebgen Lake, Montana, event; the M_s 7.3, 1983, Borah Peak, Idaho, event; and the M_L 7.1, 1954, Dixie Valley, Nevada, earthquake.

Using analytic models of subsurface faulting and accompanying surface deformation of the Teton fault, Byrd and others (1988) evaluated the role of hypothetical prehistoric earthquakes and their effects on deformation of the valley floor, incorporating the topographic profile along the 1st-order level line from Jenny Lake to the Snake River. Models of surface deformation resulting from displacement due to normal-faulting earthquakes nucleating at depths of 9.4 miles (15 km) on a variety of plausible subsurface fault geometries, with dips of 45° to 60°, were constructed. The results suggest that the present westward tilt of the valley may be due to as many as five $M > 7$ earthquakes with a total surface offset of 131 feet (40 m) in the last 15,000 years (since Pinedale glaciation) on the Teton fault.

Stop 4. South Taggart Lake Moraine (optional)

An excellent exposure of the Quaternary scarp of the Teton fault with a major left-lateral component of slip can be seen by hiking west for 1.5 miles (2.4 km) from the National Park Service Beaver Creek housing area, along the main trail and westward up and onto the south Taggart Lake moraine at the base of the range front. Here the Teton fault offsets glacial morainal material with up to 105 feet (32 m) of vertical displacement with evidence of an apparent 85 feet (26 m) of left-lateral offset. A 6.6-foot (2-m) antithetic fault scarp marks the west side of a back-tilted graben that extends for some 100s of meters north-south at this location.

Stop 5. Granite Canyon

Beginning at the main Granite Canyon trail head, on the Moose-Wilson road, an excellent exposure of the Teton fault can be seen by walking 1.75 miles (2.6 km) along the trail to the mouth of Granite Canyon. In this area, the southern segment of the Teton fault cuts Pinedale moraine, till, glacial outwash, younger debris-flow material, and fluvial deposits. Scarp heights range from 10 to 49 feet (3 to 15 m) north and south of the mouth of the canyon, with 3- to 6.6-foot-high (1- to 2-m) antithetic fault scarps east of the main fault that mark the eastern limit of a well-developed back-tilted graben structure.

The larger and older scarps, north and south of the canyon mouth, range from 26 to 49 feet (8 to 15 m) high, and are exposed in the Pinedale moraine and outwash deposits. Erosion by the modern stream channel has destroyed the antithetic scarps in the younger deposits and has modified the strike of the larger scarps. The youngest fault scarps within the modern outwash plain range from 6.6 to 10 feet (2 to 3 m) high and offset fluvial outwash, debris flow, and channel deposits.

Four Pinedale-age and younger alluvial surfaces are offset by the fault in the vicinity of the mouth of Granite Canyon. These surfaces have been identified on the basis of their geometric relationships to small recessional moraines nested within the larger Granite Canyon moraine complex, as perched or hanging stream channels cut by the fault, as debris flow levees or fluvial terraces, and as an active outwash plain.

Trenching results

A 10-foot (3-m) fault scarp was excavated in 1989 at the mouth of Granite Canyon to evaluate the displacement and age of faulting on the Teton fault. The trench exposed a 13.5-foot (4.1-m), down to the east, single-event displacement on an 85°E dipping fault. Back tilting of surfaces in the hanging wall block is approximately 3°, with a 2° depositional slope in the footwall, resulting in a net vertical displacement of 13 feet (4 m).

The faulting juxtaposed a fluvial deposit capped by a paleosol horizon against fluvial and debris flow units overlying a Pinedale age (approximately 15,000 years old) glacial till. Colluvial materials and alluvial fan deposits derived from the fault scarp have buried the down-thrown fluvial and paleosol units exposed in the trench. Charcoal fragments were observed and collected from the base of and within the paleosol horizon. Carbon dating by Beta Analytic Inc., using conventional methods and extended counting of two charcoal samples recovered from the base of the colluvial wedge and the base of the paleosol, yielded ages of 7,150 ± 120 years, and 7,240 ± 190 years, respectively.

Comparison of the displacement event recorded in Granite Canyon trench with the surface displacements associated with other earthquakes of the western U.S. Cordillera suggests that the displacement was produced by a $7.1 < M_s < 7.4$ earthquake. This is the first quantitative estimate of the expected size for large and damaging earthquakes that could occur on the Teton fault in the future. If this event is a characteristic earthquake for this area, the larger scarps immediately north and south of the trench site may be the product of three or four earthquakes of similar magnitude during the past 15,000 years.

References cited

Byrd, J.O.D., Geissman, J. Wm,.and Smith, R.B.,1988, Seismotectonics of the Teton fault and possible relationship to the Yellowstone hotspot: Eos, Transactions of the American Geophysical Union, v. 69, no. 44, p. 1419.

Gilbert, J.D., Ostenaa, D., and Wood, C., 1983, Seismotectonic study; Jackson Lake Dam and Reservoir, Minidoka Project, Idaho-Wyoming: U.S. Bureau of Reclamation Seismotectonic Report 83-8, 123 p.

Lageson, D.R., 1987, Laramide uplift of the Gros Ventre Range and implications for the origin of the Teton fault, Wyoming: Wyoming Geological Association 38th Annual Field Conference Guidebook, p. 78-89.

Love, J.D., and Montagne, J., 1956, Pleistocene and recent tilting of Jackson Hole, Teton County, Wyoming: Wyoming Geological Association 11th Annual Field Conference Guidebook, p. 169-178.

Love, J.D., and Reed, J.C., Jr., 1971, Creation of the Teton landscape: Grand Teton Natural History Association, 120 p.

Love, J.D., Reed, J.C., Jr., and Christiansen, A.C., in press, Geologic map of Grand Teton National Park: U.S. Geological Survey Miscellaneous Investigations Map I-2031, scale 1:62,500.

Morgan, L. A., Doherty, D.J., and Leeman, W.P., 1984, Ignimbrites of the eastern Snake River Plain: evidence for major caldera-forming eruptions: Journal of Geophysical Research, v. 89, p. 8665-8678.

Ostenaa, D.A., 1988, Late Quaternary behavior of the Teton fault, Wyoming: Geological Society of America Abstracts with Programs, v. 20, no. 7, p. A14.

Reed, J.C., 1973, Geologic map of the Precambrian rocks of the Teton Range, Wyoming: U.S. Geological Survey Open File Report 73-230, scale 1:62,500.

Smith, R.B., 1988, Seismicity and earthquake hazards of the Borah Peak-Hebgen Lake-Yellowstone-Teton region—implications for earthquakes in extensional and active volcanic regimes: Geological Society of America Abstracts with Programs, v. 20, no. 7, p. A12.

Smith, R.B., Nagy, W. C., and Doser, D. I., 1990, The Borah Peak earthquake sequence: regional seismicity, fault kinematics, stress field inversion, and relationship to the Snake River Plain: Bulletin of the Seismological Society of America (in press).

Smith, R.B., Richins, W. D., and Doser, D. I., 1984, The Borah Peak earthquake: seismicity, faulting kinematics and tectonic mechanism, *in* Workshop XXVIII on The Borah Peak Earthquake: U.S. Geological Survey Open File Report 85-290, p. 236-263.

Susong, D.D., Smith, R.B., and Bruhn, R.L., 1987, Quaternary faulting and segmentation of the Teton fault zone, Grand Teton National Park, Wyoming: Eos, Transactions of the American Geophysical Union, v. 68, p. 1452.

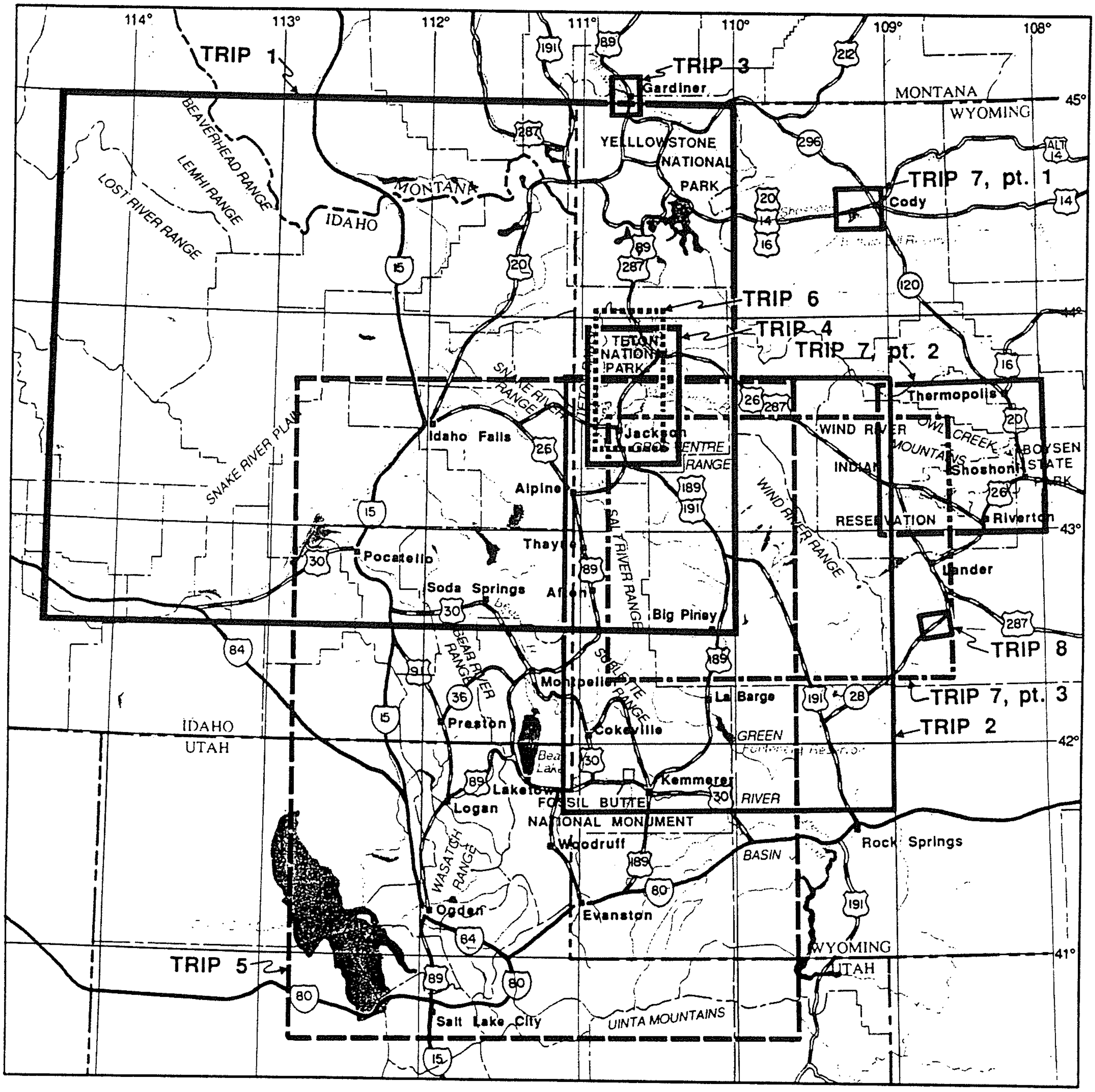
Bob Smith

Geological Survey of Wyoming • Gary B. Glass, State Geologist

Geologic field tours of western Wyoming

and parts of adjacent Idaho, Montana, and Utah

Edited by Sheila Roberts



Public Information Circular No. 29
Laramie, Wyoming
1990