

CONTEMPORARY TECTONICS AND SEISMICITY OF  
THE TETON AND SOUTHERN YELLOWSTONE  
FAULT SYSTEMS - PHASE I

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Objectives

The regional earthquake patterns of the Jackson Hole region are poorly known compared to other areas of the Intermountain region. The only published compilation is that reported by Smith, Pelton, and Love (1977) which shows the historic regional earthquakes. While these are the only long-term data available the epicenters may be in error up to 20-30 km because of the lack of close-in stations.

To the north however, the area of central Yellowstone has been monitored on a continuous basis since the early 1970's by the USGS and detailed studies have been made by the University of Utah (Smith and others, 1977). To the south, beginning near Palisades Reservoir and extending to Utah both detailed and regional analyses have been made by the University of Utah (Bones, 1978). Thus the Teton-Southern Yellowstone region has not been covered by modern high-resolution earthquake surveys.

Geologically the Teton region is in an important transition area--namely it is at the northeastern boundary of the Basin-Range type of crustal uplift and extensional tectonism, common to the areas of Utah and Idaho to the west. Seismological characteristics of this transition region are similar to those between the Great Basin and the Rocky Mountains to the south. These include: (1) scattered and diffuse patterns of earthquakes well east of the major normal faults, i.e. east of the Teton faults, (2) the lack of a clear one-to-one relationship between earthquakes and mapped faults, and (3) the definition of seismic gaps, i.e., zones of temporal and spatial quiescence along the Teton fault. The latter characteristic is particularly important in assessing the earthquake potential of these major faults. Some hypotheses for explaining the general seismicity east of the Teton fault zone and the relative quiescence of the fault include: (1) the historic monitoring of the Teton fault has been too short to accurately assess the long-term seismicity, especially if the large earthquakes are sporadic and have return-periods of hundreds to thousands of years; (2) the current stress field is in a precursor quiet period prior to failure, and eventually a large earthquake will "fill in the gap"; (3) the earthquake zone

is migrating eastward; (4) the fault may simply be inactive and not storing energy; or (5) some other aseismic mechanism such as tilt is relieving the stresses. We do not yet understand at this time what the temporal-spatial relationship is between earthquakes and faulting in the Teton-Jackson Hole region.

With this background information we have begun the initial phase of a detailed seismic study of the Teton and Southern Yellowstone fault system to be accomplished for the following objectives: (1) A detailed seismic monitoring using low portable seismographs; (2) The evaluation of epicenter and hypocenter patterns and their correlation with faulting; (3) To determine the directions of the prevailing stress field from fault plane solutions; (4) To evaluate the recurrence intervals for large earthquakes; (5) To assess the overall seismicity and its relation to the contemporary tectonics of the Teton-Southern Yellowstone fault systems; and (6) To develop an initial assessment of the earthquake hazards of the Teton-Jackson Hole-southern Yellowstone region, their possible influence upon the Earthquake Hazard Evaluation of Jackson Lake and upon the western tilt of Jackson Hole. These objectives were initiated by a 45-day earthquake survey (Figure 1) conducted in August and September, 1980.

#### Methods

Seismic monitoring in the northern Teton region was initiated with the installation of nine portable seismographs in August, 1980 (See Table 1 and Figure 1). An additional station on the west side of the Teton Range at Rammel Mountain, maintained and operated by Ricks College, was also in operation during this period of time. This array of ten stations was in continuous operation to September 20, 1980 and yielded a total of about 250, 48-hour seismograms.

The seismograph stations recorded earthquakes on battery-powered, smoked paper drums that were changed every other day. Two people were responsible for the preparation, record-fixing and changing of the records as well as maintenance of the instruments. Days of the survey that did not involve field work were spent in repairing equipment and in a preliminary analysis of records.

#### Conclusion-To-Date

Since the completion of the survey, in late September, the majority of 250 field records have been analyzed. This process includes making accurate time corrections for the records, correlating identifiable earthquakes between the stations in the array, and accurately determining the P- and S-wave arrival times at each station. Seismograms from Rammel Mountain and two additional stations in eastern Idaho

that were recorded at Ricks College from the Island Park area have just recently been obtained and will aid in accurately locating the earthquakes occurring on the west side of the Teton Range. Examples of earthquakes recorded at the Lupine Meadow station are shown in Figure 2. This figure illustrates how the characteristics of the seismic phases change with increasing distance from the station.

The preliminary analysis has shown that about one earthquake every 2 days occurs within the array. The majority of seismic activity recorded appears to be centered in the northern part of the Teton Range-southern Yellowstone caldera area near the Lewis River and Glade Creek stations. There also appears to be activity west of Lupine Meadows within the Teton Range itself.

#### Literature Cited

- Bones, D. G. (1978). Seismicity of the Intermountain Seismic Belt in Southeastern Idaho and Western Wyoming, and Tectonic Implications, (unpublished M.S. thesis), University of Utah, Salt Lake City.
- Smith, R. B., J. R. Pelton, and J. D. Love (1977). Seismicity and the Possibility of Earthquake Related Landslides in the Teton Gros Ventre-Jackson Hole Area, Wyoming Contributions to Wyoming Geology, v. 14, p. 57-64, Reprinted in Rocky Mtn. Thrust Belt Geology and Resources, p. 603-610.
- Smith, R. B., R. T. Shuey, J. R. Pelton, and J. P. Bailey (1977) Yellowstone Hot Spot, Crustal Properties from new Earthquake and Magnetic Data, Jour. Geoph. Res., v. 82, p. 3665-3676.

#### Acknowledgments

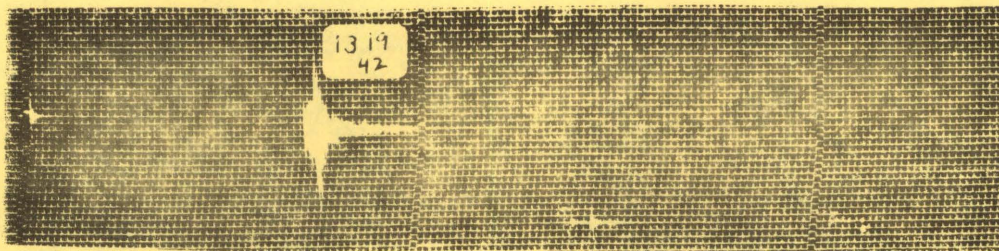
During the 1980 field work liason was maintained with Dr. J. D. Love of the U.S. Geological Survey. Two field trips were arranged: (1) one with Dr. J. D. Love to evaluate the geologic evidence for Holocene faulting and age of deformation in the northern Teton Range, and (2) a field trip led by R. B. Smith that examined the volcanic and tectonic activity of the Yellowstone caldera and the influence of the north-extending faults of the Teton system that are buried beneath the Pitchstone Plateau but appear to concentrate hydrothermal activity and remain tectonically active. Close liason was maintained with the NPS including contacts with Wayne Hamilton of Yellowstone National Park, and Pete Hayden and Ellis Richards of Grand Teton National Park.

Table 1. 1980 North Teton Seismograph Station Locations and Gains

Station	Latitude W	Longitude N	Gain (db)	Period of Operation
Pacific Creek	110°28'41"	43°53'20"	84	8/7 to 9/20/80
Glade Creek	110°46'21"	44°07'00"	84	8/8 to 9/19/80
Loon Lake	110°56'15"	44°06'42"	90	8/8 to 9/19/80
Lewis River	110°39'45"	44°14'05"	78	8/9 to 9/20/80
Ditch Creek I	110°33'12"	43°43'27"	90	8/9 to 9/5/80
Lupine Meadow	110°44'55"	43°44'12"	102	8/9 to 9/21/80
Signal Mountain	110°33'45"	43°51'03"	84	8/13 to 9/21/80
Spalding Bay	110°40'56"	43°48'57"	78	8/17 to 9/21/80
AMK Ranch	110°38'27"	43°56'41"	90	8/23 to 9/20/80
Ditch Creek II	110°36'02"	43°40'17"	90	9/5 to 9/21/80



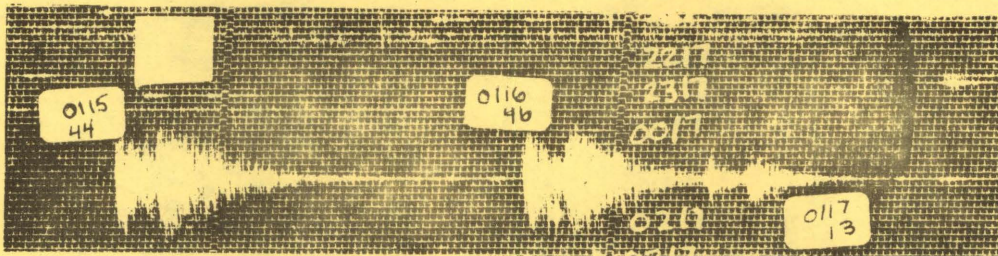
Examples of Seismic Activity Recorded at Lupine Meadow



The above microearthquake occurred about 10 km west of the station underneath the Teton Range.



This seismogram depicts a microearthquake occurring near the Glade Creek station at the northern end of the array.



A swarm of 3 separate events near the Lewis River station in southern Yellowstone is shown in the above record.



The microearthquake pictured here occurred outside of the array in area 25-30km northwest of the Loon Lake station.

Figure 2.