Operation and Development of an Earthquake Information System at Yellowstone

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Investigations Undertaken:

The principal tasks of the University of Utah-USGS cooperative agreement are to support seismic and GPS (global positioning system) station installation, maintenance, recording, and routine analyses of the Yellowstone Seismograph and GPS Networks (YSN). The primary objectives of the YSN are to monitor and assess seismicity and ground deformation that may be related to both volcanic and tectonic earthquake activity. Data from the YSN provide information for public safety, park and surrounding community management and planning, public information and interpretation, and for scientific research interests. The YSN is designed to monitor earthquakes of the entire Yellowstone volcanic system, including Yellowstone National Park (YNP) and the nearby Hebgen lake fault zone. The GPS stations provide continuous monitoring of the crustal deformation of the volcanically active Yellowstone caldera. This project provides real-time earthquake surveillance by a recently upgraded 22-station, 32-component, seismic network telemetered via FAA microwave links (at no cost to the project) to Salt Lake City, Utah, and digitally recorded at the University of Utah Seismograph Stations. The USGS Volcano Hazards Program jointly funds this cooperative project with partial support form the National Park Service (NPS) for field work. The primary products for this USGS support are annual earthquake catalogs, and the services of a regional earthquake and GPS recording and information center, including timely release of unusual earthquake activity reports to the USGS and the NPS.

Results (October 1, 1997 - September 30, 1998):

General Accomplishments. In addition to routine network operations, notable efforts under this cooperative agreement during the report period related to:

- Continued upgrading and maintenance of seismograph stations against the harsh winter conditions of Yellowstone. This included; (1) continued installation of audio bandpass filters at relay sites in order to reduce interference; (2) replacement of several aging radio transmitters and receivers throughout the network; and (3) VCO system repairs and upgrades. GPS-quality station locations continue to be determined using Trimble SSI dual-frequency receivers. Seventy-seven percent (17/22) of the stations of the Yellowstone seismograph network were visited for maintenance during the report period;

- Installation of a 3-component, broadband, digitally-telemetered seismograph station on the northwest side of the Yellowstone caldera at YMR (Madison River, WY). Field installation was completed during the report period, but a labor strike by U.S. West and miscellaneous technical problems with the installation of a telephone link between the Salt Lake City airport and the central recording lab prevented completion of the project during this report period;

- Installation of three reconditioned L4 seismometers (Norris Junction, Gravel Pit, and Pelican Cone);

- Continued upgrade of the central receive sites for all stations in the Yellowstone network (Mt. Washburn, Wyoming and Sawtelle Peak, Idaho);

- Assistance to the USGS-NEIC for maintenance of a cooperative U.S. National Seismograph Station (USNSN) located near Yellowstone Lake (LKWY);

- Installation of a continuously recorded GPS receiver at Mammoth, WY to complement a receiver located at Lake, WY. These stations monitor the deformation of the YNP caldera. Data are automatically retrieved via a dial-up telephone line every 24 hours and then incorporated into the UNAVCO GPS archives;

- Maintenance of a continuous recording, high-precision GPS station at the U.S. National Seismograph Station (LKWY) with telemetry provided by the USGS VSAT satellite system. Note that the GPS equipment was provided by the NSF-cooperative University ARI funds. Installation costs were supported by NSF funds;

- Systematic determination of local magnitudes (M_L) and M_L station corrections using local USNSN, Montana Wood-Anderson station BUT, and Utah broadband stations, for all coda magnitude (M_C) 3.0 and greater earthquakes located in the Yellowstone region since January 1, 1994 (project involved the analysis of more than 1500 earthquakes in the Intermountain seismic belt including 271 events of a major aftershock sequence, and will be completed before early 1999). Analysis continued on the recalibration of the Yellowstone coda magnitude scale. Over 100 Wood-Anderson seismograph records principally from BUT (Butte, Montana) and IRCI (Idaho Falls, Idaho) with supplemental data from USNSN stations at Dugway and Yellowstone Lake were analyzed;

- Steps towards submitting 18 years of Univ. of Utah short-period waveform data to the IRIS Data Management Center in SEED format, including (1) use of IRIS's PDCC (Portable Data Collection Center) software, (2) compilation of a database inventory of instrument components for all stations in our network since digital recording began in 1981, and (3) compilation of system response information for all past and present stations in our network;

- Continued software development to integrate new digital data streams (REF TEK and USNSN) with existing analog data streams for routine analysis;

- Completion of a network inventory for the CNSS (see http://www.cnss.org/NETS) and major progress towards a comprehensive station inventory for the IASPEI handbook;

- Submission several times per day of earthquake catalog data for the Utah region to the Council of the National Seismic System's (CNSS) composite catalog;

- Assistance to the National Park Service with long-term plans for implementing volcano and earthquake hazard assessment and identifying manpower needs;

- Analysis of space-time variations of seismic source mechanisms and related stresses of Yellowstone; and,

- Discussions with USGS, Menlo Park volcano seismology group regarding implementation of long-period event detection software (within Earthworm), and as part of M.S. student (G. Waite) thesis research on Yellowstone National Park seismicity.

Network Seismicity. Figure 1 shows the epicenters of 1224 earthquakes ($M \leq 4.9$) located in part of the University of Utah study area designated the "Yellowstone region" (lat. 44° - 45.17° N, long. 109.75° - 111.5° W) during the period October 1, 1997 to September 30, 1998. The seismicity sample includes 57 shocks of magnitude 3.0 or greater and five shocks of magnitude 4.0 or greater. The largest earthquake within the Yellowstone region during the report period was a shock of magnitude 4.9 on September 29, 1998 (12:59 UTC), located 7 miles SSE of Fishing Bridge, WY. Intense earthquake swarms continued to be recorded in the Yellowstone National Park.

Non-technical Summary: The principal task of the Yellowstone Seismic and GPS Networks (YSN) is to monitor earthquake activity and crustal deformation in Yellowstone National Park and surrounding regions. The 22-station seismic network is centrally recorded in Salt Lake City, Utah, as part of the University of Utah's regional seismic network. Data from the 2-station GPS network are archived at UNAVCO national data center in Boulder, CO. A total of 1224 earthquakes were located in the study region, including 57 shocks of magnitude 3.0 and larger. The largest earthquake within the Yellowstone region during the report period was a shock of magnitude 4.9 on September 29, 1998, located 7 miles SSE of Fishing Bridge, WY. The most notable efforts during the report period related to continued upgrading of field electronics for survival in Yellowstone's harsh, rugged environment, installation of a state-of-the-art seismograph station, and installation of a global positioning station.

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Availability of Data:

All seismic waveform data archived by the University of Utah Seismograph Stations are available upon request (typically delivered to the user in SAC ASCII or binary format). Earthquake catalog data for the Utah region are available via anonymous ftp <ftp.seis.utah.edu: pub/UUSS_catalogs>, or by e-mail request to request-quake@eqinfo.seis.utah.edu, or via the Council of the National Seismic System's composite earthquake catalog, <http://quake.geo.berkeley.edu/cnss>. See also the University of Utah Seismograph Stations homepage on the World-Wide Web <http://www.seis.utah.edu>. The contact person for data requests is Susan J. Nava, Network Manager, tel: (801) 581-6274; e-mail: nava@seis.utah.edu. GPS data are available by contacting Dr. Robert Smith, tel: (801) 7129; e-mail: rbsmith@mines.utah.edu.

Seismicity in the Yellowstone Region October 1997 - September 1998

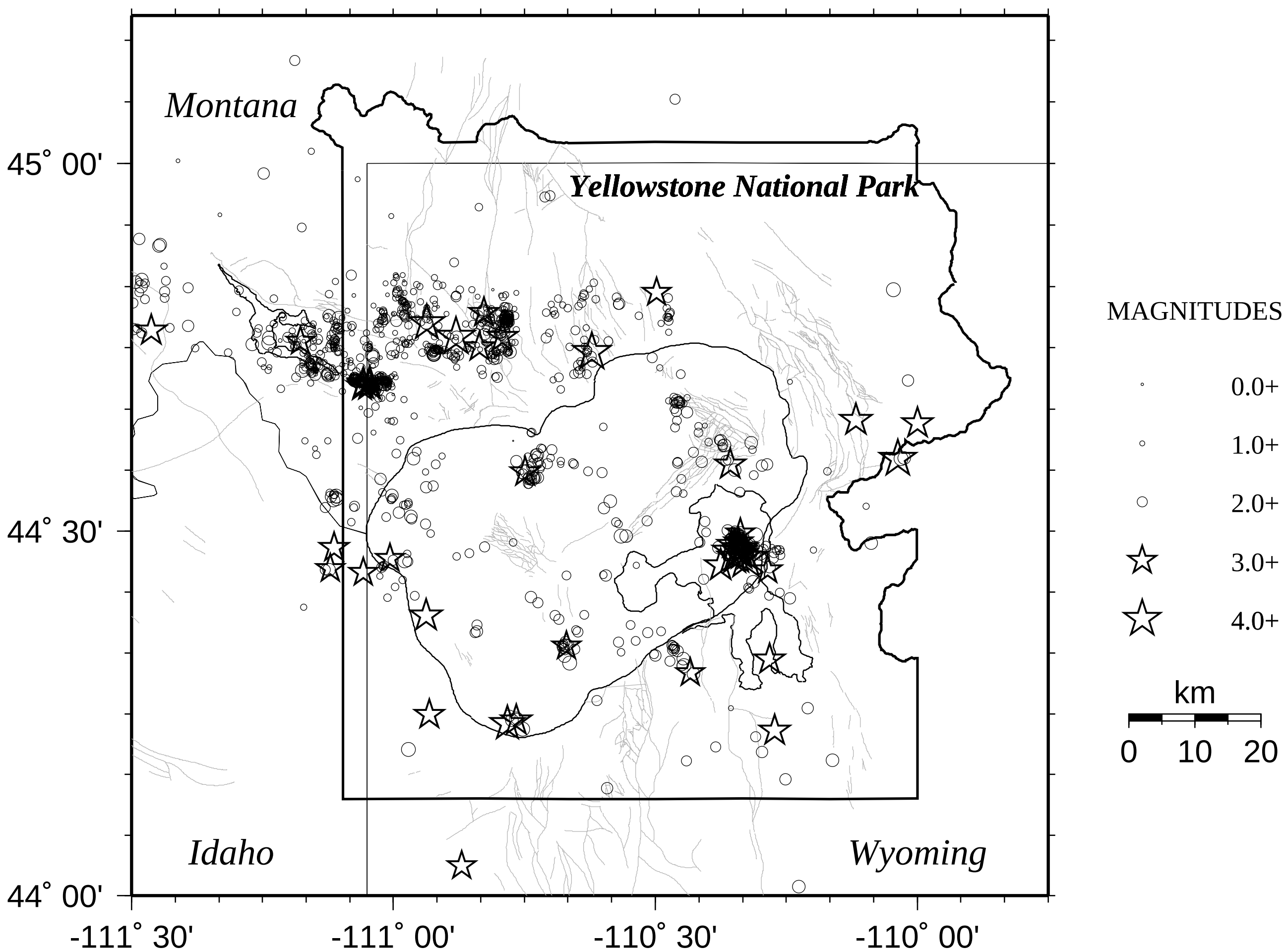

Figure 1 Earthquakes in the Yellowstone Region, October 1, 1997 through September 30, 1998. Shocks of magnitude 3.0 and larger are plotted as stars; those less than magnitude 3.0, as circles.