

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Intensity survey of the Borah Peak,
Idaho, earthquake of October 28, 1983

by

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Introduction

The magnitude 7.3 (Ms) east central Idaho earthquake occurred on October 28, 1983, at 14:06:06.3 UTC (08:06 a.m., MDT). The earthquake hypocenter was located at 44.046 degrees North; 113.887 degrees West with a fixed depth of 10 km (PDE) by the U.S. Geological Survey in Golden, Colorado.

This earthquake was characterized by surface faulting, earthquake fountains (water spouts), landslides, light phenomenon, and the fall of very large boulders at Challis. Other geologic effects were ground cracks, the development of a lake, changes in the flow of old springs, and the creation of new springs.

Preliminary reports indicated the earthquake was felt in eight states: Idaho, Montana, Nevada, North Dakota, Oregon, Utah, Washington, Wyoming, and in the Canadian Provinces of Alberta, British Columbia, and Saskatchewan.

Two children were killed in Challis and one woman was injured at Mackay by the collapsing walls of buildings.

A field investigation was conducted from October 29 through November 2, 1983. The field survey was designed to determine intensities in the epicentral area by documenting the amounts and types of damage to structures, to household furnishings, and effects on people.

The results of the field survey, with photographs of earthquake damage and geologic effects, are given in this report.

Topographic Setting

The earthquake epicenter was located in the Barton Flats area. This area was located south of the Big Lost River and near the northern margin of the White Knob Mountains. This location was 10 miles northwest of Mackay and approximately 30 miles southeast of Challis--the two largest communities closest to the epicenter (fig. 1 and fig. 2). The alluvial valley, bordered on the east by the Lost River Mountain Range, on the west by the Pioneer and White Knob Mountains, and on the north by the Salmon River Mountains at Challis, was oriented in a northwest-southeast direction. Many of the rural homes in the sparsely populated valley were located along the meandering Big

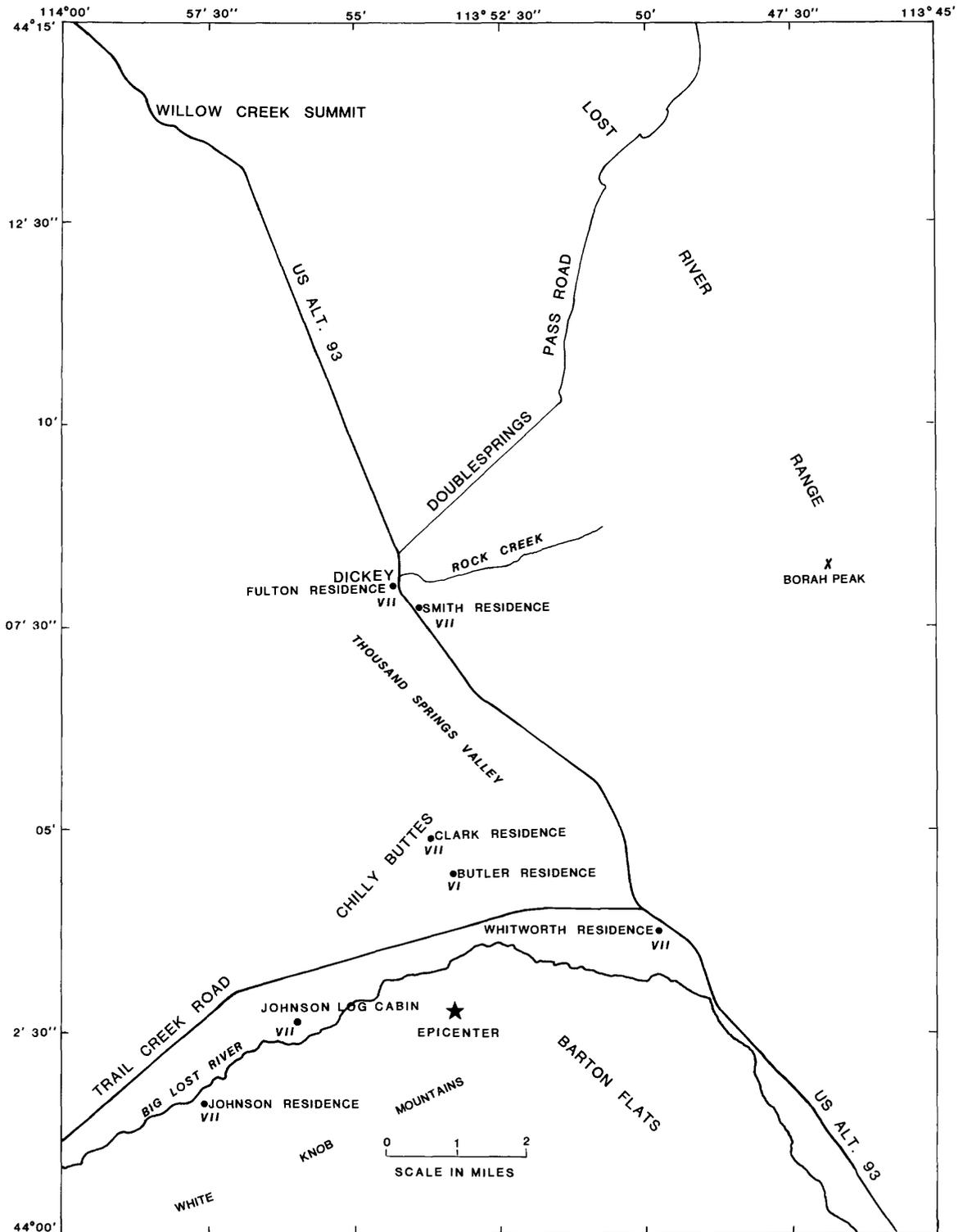


Figure 1.--A schematic map that shows the locations of the topographic features near to and north of the epicenter. Modified Mercalli intensities (Wood and Neumann, 1931) at the surveyed sites are shown as Roman numerals.

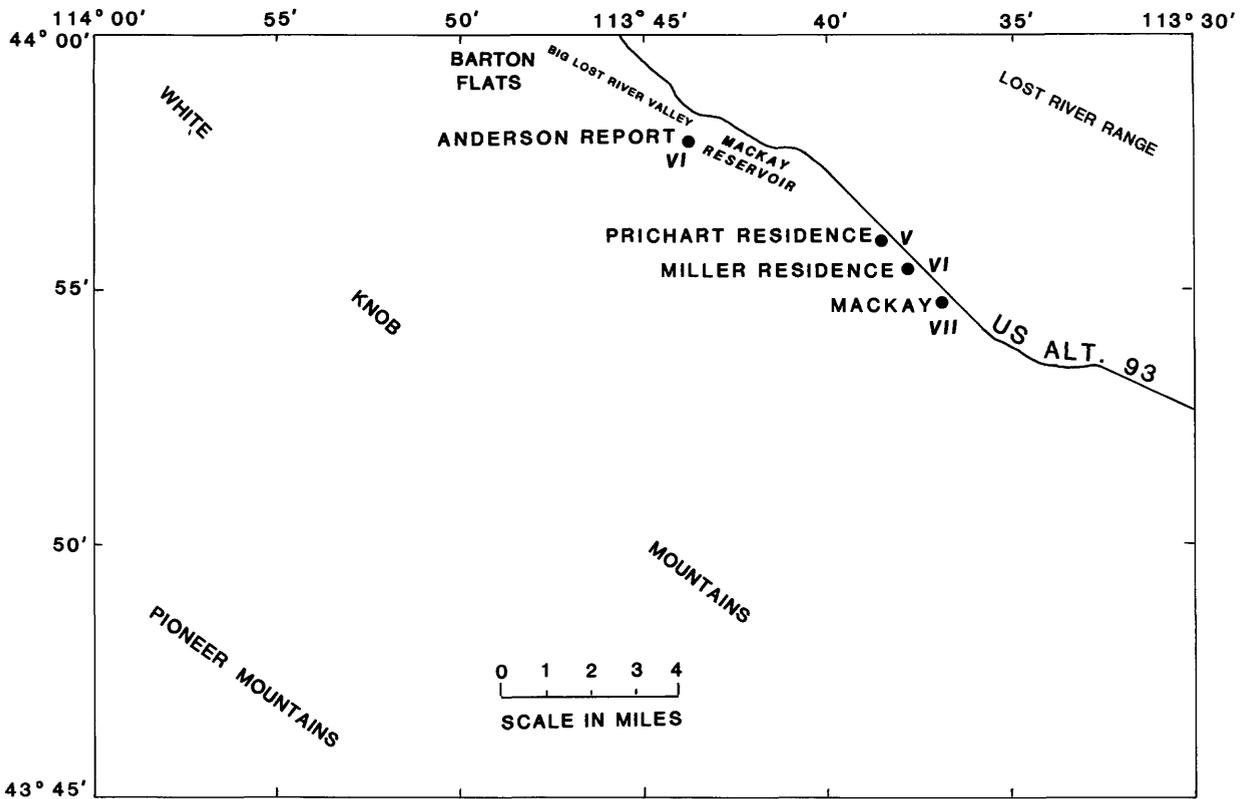


Figure 2.--A schematic map that shows the topographic features south of the epicenter. Modified Mercalli intensities (Wood and Neumann, 1931) at the surveyed sites are shown as Roman numerals.

Lost River.

Faulting

Surface faulting along the west side of the Lost River Mountain Range was visible from U.S. Alternate (Alt.) 93 Highway. Preliminary (reported) estimates measured from aerial photographs of the surface faulting showed that a continuous segment of surface rupture extended 24 miles toward Challis from an approximate point 5 miles northwest of Mackay Reservoir. The west side of the fault scarp was reported to have an average drop of 8 feet with some left lateral movement. The width of the fault scarp fracture zone was variable throughout its length. Figures 3 through 5 are photographs of the fault scarp and fracture zone. These photographs were taken three miles east of Dickey, Idaho on Doublesprings Pass Road and on Rock Creek.

An eyewitness account of the faulting in the Lost River Mountain Range by a camper, Lawana Knox, was written by Jerry Belcher and Richard Meyer of the Los Angeles Times. The eyewitness account was printed in the October 31, 1983 edition of the Denver Post Newspaper. The exact location of the campsite was unclear, but it was suspected that the campsite location was south and east of Challis. Due to the uniqueness of the event, it was thought to be appropriate to include excerpts of the article: "At first, I heard a funny roar, I thought it was the wind blowing up the canyon. I saw the sagebrush and grass wiggling and started to shake and I thought 'Earthquake'. The next thing I knew, it had thrown the gun, a 245 Winchester out of my hands, and I couldn't get it. It felt like somebody was shaking me by the shoulders and I had the sensation that it would throw me on my face. I was disoriented. I sat down. The power poles were bending back and forth, lines whipping. There was nowhere for me to go, so I just sat there and waited. Then there came this horrible roaring. I looked and the earth started cracking. Just everywhere I looked, the earth started to open up, just like someone had taken scissors and started cutting. I could see dust a flying and a big crack going right along the mountains. I thought it would keep going and I just sink. It went along for miles. I could see it going." "...There was no way you could have stood up--as the the ground split apart 150-200 yards in front of her".

Mackay Dam

Mackay dam, an earthen dam at the south end of Mackay Reservoir, was located 7 miles southeast of the epicenter. Neither the gravel-surfaced road on top of the dam nor the concrete spillway was cracked. Rock falls from the adjacent hillside littered the concrete spillway. Following the earthquake, a damage survey of the dam site by state investigators was conducted. The investigators reported that the dam was safe.

Roads and Bridges



Figure 3.--The upthrown side of the fault scarp. The location is 3 miles east of Dickey, Idaho on Doublesprings Pass Road. The photograph is looking east toward the Lost River Mountain Range.



Figure 4.--An oblique view, across the fracture zone, of the upthrown side of the fault scarp on Doublesprings Pass Road. Looking northeast.



Figure 5.--The fault scarp and fracture zone on Rock Creek. The location is 3 miles east of Dickey, Idaho and a mile south of Doublesprings Pass Road. The wooden pole is 6 1/2 feet high. The northern flank of Mount Borah appears in the upper right corner of the photograph.

Cracks in the asphalt road surface were seen at several locations on U.S. Alt. 93, the main highway through the valley.

Moderate cracking, coupled with slumping, was observed on U.S. Alt. 93 a mile north and a mile southeast of the Trail Creek Road intersection. The asphalt road surface was cracked longitudinally with transverse cracks and patched areas cutting across the road (fig. 6). As we continued to cross these areas for several days, we noted that the roadway was becoming very wavy.

Other locations of road cracks on U.S. Alt. 93 were at Leslie, 2 miles northwest of Mackay, and on the south side of Willow Creek Summit.

Several of the roads leading over the mountain passes were blocked by rockslides and fallen boulders.

Southeast of Challis, on U.S. Alt. 93, a steel-truss bridge that spans the Salmon River appeared to be undamaged.

Ground Cracks

Large ground cracks occurred in an open field at a mile north of the Trail Creek Road intersection on U.S. Alt. 93 (fig. 7 and fig. 8). The ground cracks, which varied in length, width, and depth, trended northeast toward the Lost River Mountain Range. The dry cracks were located 20 yards east of the highway. The Thousand Springs Valley marsh area was adjacent to the west side of the highway (fig. 9).

Earthquake Fountains

Earthquake fountains or water spouts occurred at two known locations. The most spectacular report came from Chilly Buttes which was located in the Thousand Springs Valley area. The other location was near the north entrance to Mackay Reservoir.

At Chilly Buttes (2 miles north of the epicenter), the earthquake fountain activity was located mostly on the north and east flanks of the Buttes and in the adjacent flat areas. According to residents, Mr. Clark and Mr. Butler, the water spouts on the sides of the Buttes and in the adjacent flat area shot black water 10-20 feet into the air. On the sides of the Buttes, overlying vegetation around the holes was uprooted by the force of the ejecting water. The holes created by the water spouts, which varied in size and shape, were reported to be deeper on the sides of the Buttes than in the flat area near the base of the Buttes (fig. 10 through fig. 13).

The following account of the earthquake was given by Mr. Anderson who was fishing near the junction of Parson's Creek and Warm Springs Creek (43.968



Figure 6.--Asphalt road cracks on U.S. Alt. 93 which is the main north-south highway through the valley. The white line at the edge of the roadway was offset 4 1/2 inches to the left. The location is a mile north of the Trail Creek Road intersection. Asphalt road cracks at other locations were similar in appearance.



Figure 7.--Open ground cracks on the east side of U.S. Alt. 93. The location is a mile north of the Trail Creek Road intersection. Lost River Mountain Range appears in the background.



Figure 8.--A close-up view of one of the larger ground cracks shown in Figure 7. The crack was estimated to have a depth of 15-18 feet and 6-8 feet in width.



Figure 9.--The Thousand Springs Valley area borders the west side of U.S. Alt. 93. The ground cracks, as shown in Figures 7 and 8, were located on the east side of the highway. A low fog bank hangs over the valley at the time this picture was taken.



Figure 10.--One of the water spout (earthquake fountain) holes located at the base of Chilly Buttes. The man, which is standing next to the exit of the water spout hole, is 5 1/2 feet tall.



Figure 11.--The overlying vegetation was uprooted by the force of the ejected water at this water spout hole.



Figure 12.--Two water spout holes located midway up on the east side of Chilly Buttes.



Figure 13.--One of the many collapsed water spout (earthquake fountain) holes in the flat area adjacent to the the base of Chilly Buttes. The hole was estimated to measure 2 feet deep, 17 feet lengthwise, and 10 1/2 feet wide.

degrees North Latitude; 113.729 degrees West Longitude) at the north end of Mackay Reservoir. This location was approximately 5 miles southeast of the epicenter. "I was standing on a gravel sand bar when the earthquake struck. Cracks appeared in the bar and began to gurgle water. Then three or four water spouts with 3 to 4 inch holes opened up and water shot up to 3 feet in the air. The gravel bar shook like a marshmallow. It was very difficult to stand. Some of the water spouts spewed black water; others spewed clear water". Mr. Anderson commented that when he waded over to the bar the water was about calf-high and after the shaking subsided and he waded out, the water was waist-high. He estimated the water had risen nearly 10 inches. As he reached higher ground, though still in the marsh area, he could see numerous water spouts in the nearby area. Since he had previously experienced a heart attack, he indicated that the sensation was similar to a heart attack without the chest pain. The sound that preceded the earthquake was similar to that of an approaching heavy mining truck. The geese on Mackay Reservoir were very noisy prior to the quake. Following the earthquake, the water became muddy and driftwood began to float by.

Additional intensity reports in the vicinity of the water spout activity can be found under the Chilly Buttes heading in the section Reports and Descriptions of Effects.

Landslides

Dust clouds from activated landslides were reported to be visible from almost every canyon in the Lost River Mountains.

Most of the mountain sides bordering State Highway 75 between Challis and Clayton showed recent landslide scars (fig. 14).

Earthquake Light

An unusual light phenomenon was observed by two independent persons on the morning of and prior to the earthquake. The following brief paragraphs are the descriptive accounts of the light phenomenon.

Gordon Fulton, a graduate of Idaho State University, reported that he had looked at the sky about 7 a.m. (MDT), before the sun had risen, and observed a brilliant red sky over the Lost River Mountains.

Before the quake occurred, Mr. Johnson indicated that he looked out the east window of his residence to check the sky for the day's weather. He noted that the sky was a brilliant red color over the Lost River Mountain Range; something he had never noticed before. An hour or so later, after the earthquake, the sky color had moderated a bit.

Reports and Descriptions of Effects



Figure 14.--A photograph taken between Challis and Clayton on State Highway 75. The lighter scars on the hillside are the result of the landslides activated by the recent earthquake. This is a typical picture of the mountain sides in this area.

In this section the reports are grouped into three areas: the epicentral, the western, and the eastern areas. Arco, Idaho was the hinge-point for each group. The reports in each group are organized in alphabetical order by town name, by residence owner, and by contributor. The coordinates, if given, are expressed in decimal degrees.

The locations of the communities, which were visited in and around the epicenter, are shown in Figure 15. Preliminary estimates of the Modified Mercalli intensities (Wood and Neumann, 1931) are assigned to these reports which are shown in Figure 15. These intensity assignments may change as additional data becomes available.

The Epicentral Area

The epicentral area extended from Arco, Idaho; northwest to Challis; and southwest to Clayton, Idaho.

Arco, Idaho

The owner of the Lazy-A Motel reported that she had heard of plaster cracks in the interior walls in the Jr. and Sr. High School buildings. There were a few cracks in the exterior brick walls. The three-story, brick schools, approximately 40 years old, were located across the street from the Lazy-A Motel.

Sawtooth Bar (1/2 block west of U.S. Alt. 93 on Grand Street): The building was not damaged. Beer steins and bottles fell from a narrow shelf behind the bar. Few glasses fell and broke.

Arco Drug (middle of block between Idaho Street and west of U.S. Alt. 93): Many of the light toiletrie items were shaken down from the shelves. Some glass items fell. The building was not damaged.

Royale Cafe (corner of Idaho Street and Grand Street): The single-story, brick building was not damaged. The waitress reported it shook real good, but nothing was displaced.

Lazy-A Motel (Grand Street): The single-story, wood-frame structures were not damaged. The owner reported that her lipstick container overturned on the glass shelf under the mirror.

Anderson Residence: At this residence, two blocks west of the Lazy-A Motel, dishes or glassware rattled, but the dishes and glassware were not shaken down or broken. The home was not damaged; a hanging planter swung; and it was very dusty.

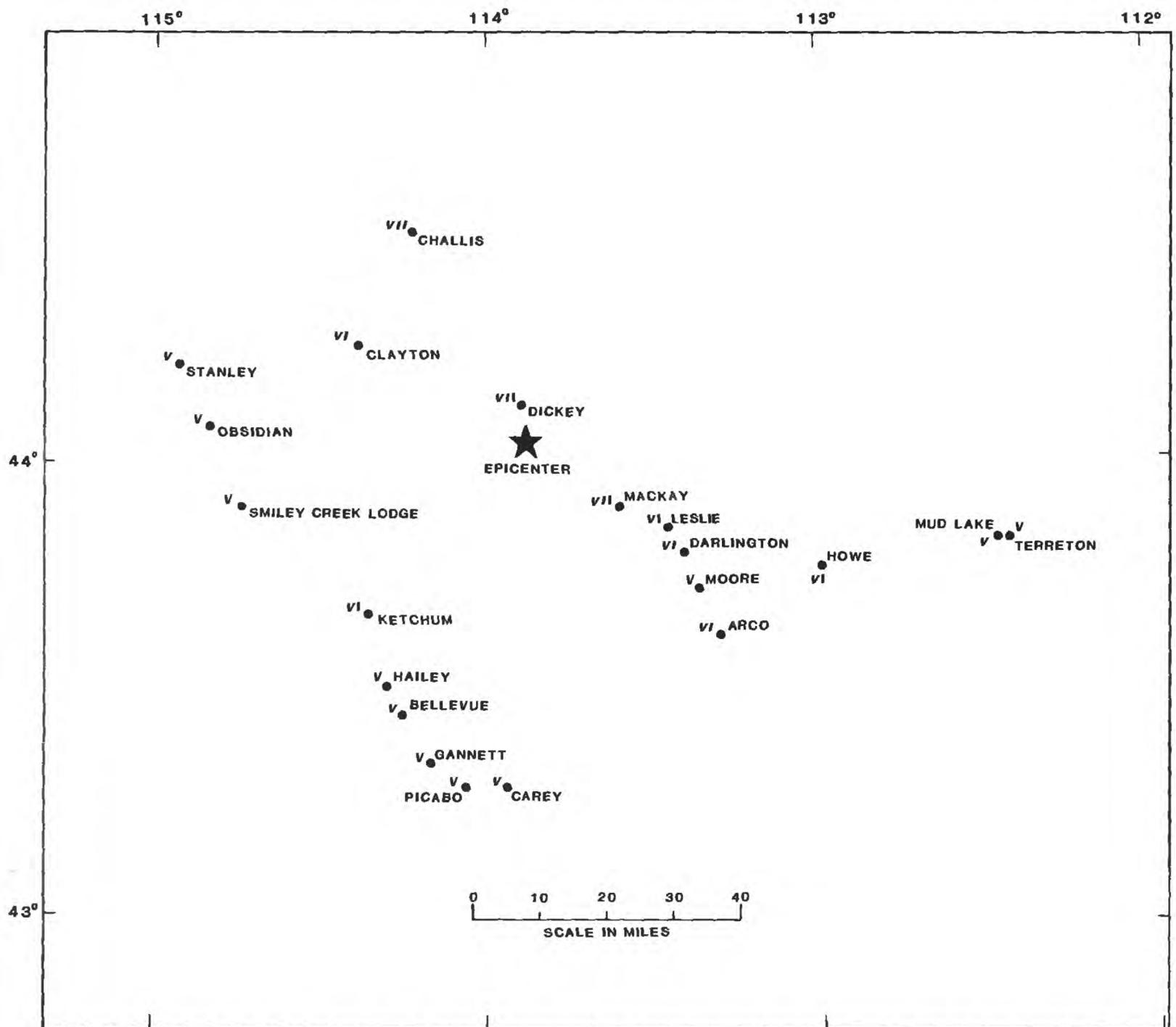


Figure 15.--A map that shows the locations of the communities visited during the field survey. Modified Mercalli intensities (Wood and Neumann, 1931) at the communities are shown as Roman numerals.

Challis, Idaho

In comparison to Mackay, the visible damage to buildings and chimneys in Challis was less severe. Window damage was not observed on Main Street. There were isolated instances of chimney damage which was mainly to brick chimneys without flue-liners. The chimney damage varied from a few bricks shaken down to the severest observed instance of bricks shaken down to roof line. Cinder block chimneys were not as severely damaged as the brick chimneys in many of the observed instances. Only mortar-seam cracks were seen in a few of the cinder block chimneys. Many of the cinder block chimneys, which were constructed by the side of the house, were supported by a metal strap. The metal strap was wrapped around the chimney and attached to the house near the roof line.

Dishes, wall ornaments, and knick-knacks, commonly fell and broke in many homes.

Huge boulders, which rolled down the slopes of the mountains in the northwest section of Challis, were spectacular (fig. 16 and fig. 17). Some of the homes adjacent to the slopes were damaged by the fallen boulders. A huge boulder narrowly missed the residence of Georgia Smith. The house was located one block away from the mountain slope. The boulder rolled between two houses at the base of the slope, down the road, across a wooden bridge, and came to rest in the Smith's front yard. The side of the front porch was slightly damaged on their wood-frame house (fig. 18).

It was reported that in an area east of Challis some springs dried up; others which were dry flowed again; and new springs appeared.

Second-hand Store on Main Street: The building was constructed of concrete block in the early 1900s. At the time we were there, workers had pulled down much of the rubble from the building's concrete block store front. The original damage, as it could be determined from newspaper photographs, was the partial collapse of the concrete block store front about midway from the top (fig. 19). This vacant building was one of the older buildings in Challis.

IOOF Lodge on Main Street: The lodge hall was in a two-story, wood-frame building. The brick chimney, without a flue-liner, was shaken down to the roof line. The roof had a hump in it, but this could not be confirmed as earthquake damage.

Sew and Save Thrift Shop on Main Street: The structure was a one-story, cinder block building. The cinder block chimney, on top of the building, was cracked along the mortar seams. No other damage to the building was observed (fig. 20).

Challis High School on Main Street: Inside the school it was reported that two interior walls were shaken loose; cracks in plaster walls, damage to ceiling tiles (some fragments fell according to a young lady who was in the



Figure 16.--A view of the large boulders at the base of the mountain slope shown in Figure 17. The slope is located in the northwest section of Challis, Idaho.



Figure 17.--A view of the mountain slope and the location of the boulders near the top. The size of the fallen boulders can be seen in Figures 16 and 18. Note the building and the fallen boulders at the base of the slope. Challis, Idaho.



Figure 18.--The large boulder, which fell down the slope shown in Figure 17, came to rest in the front yard of Georgia Smith's residence. Challis, Idaho.



Figure 19.--The partial collapse of the concrete block store front. The vacant second-hand store, which was one of the older buildings in Challis, was located at the western edge of the business district on Main Street. The original earthquake damage was masked by the removal of additional portions of the front wall before this photograph was taken.



Figure 20.--The Sew and Save Thrift Shop on Main Street in Challis, Idaho. The exterior walls of the building were not damaged. Enlarged mortar-seam cracks in the cinder block chimney.

school building at the time of the earthquake), hanging pictures were thrown down from the walls, and books and other objects were shaken to the floor from shelves and desks.

The stone front entrance, which was pulled away from the building, was the significant structural damage to the High School. Some of the stone facing at the northeast corner of the front entrance fell (fig. 21). At the rear of the building, numerous cracks were observed along the mortar seams in the 10-foot tall chimney. Similar cracks occurred in the exterior walls (fig. 22). This building was another one of the older structures in Challis which was built in 1922. The building was closed. The new High School was reported to be undamaged.

Garden Creek Food Market on Main Street: The wood-frame, single-story building was not damaged on the inside or outside. The owner had taken pictures of the store after the earthquake. The pictures showed that the shelves were mostly cleared of merchandise. Glass jar merchandise was broken from the fall. The refrigerator doors, with latches, were thrown open; and the refrigerator contents were thrown out.

Chilly Buttes Area (44.081N.,113.895W.)

Butler Residence (44.075N.,113.888W.): This residence was located about a mile east of Chilly Buttes. The residence was a one-story, wood-frame structure set over a concrete basement. The house and the well-mortared, flue-lined chimney were not damaged. The residents were not at home at the time of the earthquake. When they returned, cabinet doors were open and many dishes were scattered and broken on the floor. Medium to heavy furniture was overturned, but the furniture was not broken. The refrigerator was moved away from the wall, but it was not overturned. Several things were shaken from the walls including two mounted deer heads on plaques. Windows were not damaged.

Mr. Butler briefly indicated that the water spout activity at Chilly Buttes also occurred at the time of the big Yellowstone earthquake in 1959.

Clark Residence (44.083N.,113.887W.): This residence was located at the base of the northeast corner of Chilly Buttes. It was a one-story, wood-frame house set on a stone foundation, but not tied to it. This house was a result of two houses joined together. There was a slight shifting of the house relative to the foundation. A couple of tiers of bricks fell from the unlined chimney. The plaster ceiling was cracked. Glassware and dishes were broken. According to Mr. Clark, the quake shook the house so hard that he and his family could not stand up long enough to get out of the house. He attempted to leave the area in his truck after the shaking had subsided. Due to the large amounts of water cascading down the slopes of Chilly Buttes from the water spouts located on the Butte sides, and water shooting up from the ground along the road, it was impossible to get through. The remains of a water spout, which resembled a large puddle of water, gurgled water in his corral. Windows were not damaged.



Figure 21.--The northeast corner of the stone front entrance of the old Challis High School which is located on Main Street. Some fall of the stone facing was evident. The major structural damage to the school was that the stone front entrance was pulled away from the building.



Figure 22.--Enlarged mortar-seam cracks in the chimney at the rear of the old Challis High School. Similar mortar-seam cracks occurred in the west exterior wall.

Clayton, Idaho

Clayton Merchantile Grocery and Gas Station (State Highway 75): The grocery store was a single-story, cinder block structure. The exterior walls of the building were not damaged. A few small cracks were observed in the interior plaster walls. The owner reported the general unstocking of the shelves. Several wine bottles fell and broke.

The community (population of 43) was located in a narrow canyon along the highway. Rockslides were a common occurrence on the mountain slopes adjacent to the town. The grocery store owner reported that rocks were coming down everywhere.

A lady in the store, who resided in Squaw Canyon north of Clayton, reported that new springs were created since the earthquake.

Darlington, Idaho

Darlington Store (U.S. Alt. 93): The one-story, log structure was set on a concrete foundation. Many items came off the shelves; and some glass merchandise was broken. On one of the wooden shelf units, both ends of the shelf unit were split lengthwise. The earthquake sound was like a heavy truck approaching the building. Small and very minor cracks occurred in the newly painted wooden false ceiling beams. The owner braced herself in the doorway; however, she reported that it was not difficult to stand. Some chinking fell out from between the logs which formed the exterior walls.

At her home, across the highway, some items fell off the walls. Knick-knacks fell; and some were broken.

Dickey, Idaho

Fulton Residence (44.134N., 113.905W.): It was a one-story, log building with an attic that was originally built in 1880 (fig. 23). Two brick chimneys, without flue-liners, were shaken down to roof line. One chimney fell down inside the house. Bricks fell on the roof from the other chimney. The living room was built over a cinder block basement with the remaining rooms, which were added later, set on a concrete foundation on the ground. Mrs. Fulton commented that items on the shelves were moved in the room over the basement; whereas the items on shelves in other rooms were knocked off.

Many wood and glass antique items were broken throughout the house. Cabinet doors flew open and large quantities of glassware, and dishes were dumped and broken on the floor. The refrigerator door was flung open and the contents were dumped onto the floor. The refrigerator was not moved. Bookcases filled with books were not moved. Pictures, knick-knacks and



Figure 23.--The Fulton residence at Dickey, Idaho. The log building was not damaged. The two brick chimneys were shaken down to roof line.

shelves came down from the walls. Light furniture, table and floor lamps were overturned; some of these pieces were broken. In the basement, jars and can goods were thrown from the shelves with many of the glass goods broken. The stairway leading up to the attic was filled by shifted furniture, luggage, and filled cardboard boxes. Windows were not damaged.

The residents reported that they could not stand up to exit the house because of the strong lateral motion.

A wood-frame house, set over a concrete basement, was located about 50 yards south of the Fulton residence. The house (under construction) and the reinforced concrete basement were not damaged (fig. 24).

Behind the Fulton residence, the trailer hitch of a piece of heavy farm equipment was shaken off the cinder block support (fig. 25). A tractor's transmission, which was suspended from a chain hoist, was flung westward over the tractor's fender. A portion of the chain was broken (fig. 26). Gordon Fulton reported that the fender was not touched by the transmission.

Johnson Residence (44.031N.,113.960W.): The main residence, a single-story, wood-frame house, was not damaged. Two heavy pictures vibrated against the wall, but the pictures remained on the wall. Knick-knacks vibrated on the shelves. A few heavy horse trophies fell from a shelf, but Mrs Johnson managed to catch them before they hit the floor. A few dishes fell from the table and broke. Dishes and glassware were not shaken from the kitchen cabinets. The refrigerator was moved away from the wall over a linoleum floor.

Mr. Johnson reported that the family was at the main house eating breakfast when the earthquake struck. He held on to the sink to remain standing. A plate, on which a piece of toast was leaning, was vibrated off the table. The Johnson's daughter (probably early 20s) could not open the back door of the house to get outside during the earthquake.

Mrs. Johnson commented that water spouts occurred on their property during the 1959 Yellowstone earthquake, but these same areas were not reactivated during this quake. According to her, the water spouts on their property formed a northeasterly trending line up to the water spout activity at Chilly Buttes.

Johnson Stockade House: The two-story, log-stockade, A-frame house was located about 100 yards away from the main house (fig. 27). The house was set on a concrete foundation. A stockade house differs from a log cabin in that the logs are vertical rather than horizontal. Mr. Johnson reported it was "damn well constructed". The two well-mortared brick chimneys, without flue-liners, fell from the roof, through the attic, and into the second-story rooms. The rooms were cluttered with bricks. It was difficult to tell if furniture damage in these rooms was a result of the earthquake or due to the fallen bricks. Downstairs, there were a few cracks in the plaster ceiling and walls. In the kitchen, a few glasses and dishes were shaken to the floor from the cabinet top by the sink. In the utility room, which joined the kitchen and served as the rear entrance to the house, many of the items on the walls



Figure 24.--The frame building was located approximately 50 yards south of the Fulton residence. The building (under construction) or the reinforced concrete basement was not damaged.



Figure 25.--The trailer hitch of the farm equipment was shaken off the cinder block support. Fulton residence.



Figure 26.--The transmission of this tractor was suspended by the chain hoist. The transmission was flung westward (to the right) over the tractor's fender. The chain snapped and deposited the transmission on the floor of the building. The back hoe portion of the tractor was shaken off the cinder block support. Tools and cans of oil were shaken from the shelves and work tables in this building. Fulton residence.



Figure 27.--The log stockade house at the Johnson residence. The two brick chimneys fell from the roof, through the attic, and into the second-story rooms.

were thrown down. A washing machine or dishwasher, which was not connected, was overturned. Outside of the cabin, the chinking between the logs remained intact. Mr. Johnson reported that the building was noticeably tilted after the earthquake. This fact was verified by his wife. The leaning or tilting of the stockade house, which according to Mr. Johnson had straightened up, was not observed by the authors. Windows were not damaged.

Johnson Log Cabin: The two-story, log cabin was located across the Big Lost River--1.7 miles northeast of the main residence. Mr. Johnson reported that chimney bricks fell away from the metal flue-liner. Inside the cabin, we were told that a few items fell. Unconfirmed.

Leslie, Idaho

Church of Jesus Christ of Latter Day Saints, Leslie Ward (U.S. Alt. 93): The church was housed in a wood-frame, brick-veneer structure. One section of the brick-veneer, which was located between the windows, fell to the ground from the north wall. The brick-veneer was held in place by a nail which was placed through the mortar and into the wood-frame. Log poles were placed against the exterior north wall to prevent further damage to the building (fig. 28). One window was cracked; however, it could not be confirmed as earthquake damage. Cracks in the asphalt road surface were observed near the church.

Mackay, Idaho

By the time the authors arrived, October 29 about 3 p.m., MDT, much of the earthquake damage was cleaned up and reconstruction of the damaged establishments was in progress.

Photographs, Figures 29 through 35, 37, and 40 through 42, were taken about 11 a.m., MDT on the day of the earthquake. The vivid effects of the earthquake to structures along the 3-block-long business district on Main Street are shown in these photographs.

The summary of damage to the business establishments listed below includes some of the visible earthquake effects, but the list does not imply that these stores were the only damaged buildings. Most of these buildings were closed.

Windows were damaged in several of the buildings. The windows were probably damaged by the falling bricks rather than by the earthquake shaking.

Perks Bar (north side of West Main): This two-story brick building was reported to be seriously damaged. The exterior brick front wall partially collapsed into the street (fig. 35).

City Hall (south side of West Main): A gaping hole occurred above the



Figure 28.--The north wall of the Church of Jesus Christ of Latter Day Saints, Leslie Ward at Leslie, Idaho. One section of the brick-veneer facing fell to the ground. Note the log poles which were placed against the exterior north wall to prevent further damage.



Figure 29.--Main Street in Mackay, Idaho. The business establishments on the north and south sides of Main Street. Looking toward the east. The rubble in the street is from the partially collapsed wall of the Custer Hotel. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 30.--Ivie's IGA Grocery in Mackay, Idaho. The bricks and the awning were shaken down from the store front. The theater marquee was apparently not damaged. Looking east along the south side of Main Street. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 31.--Looking east along the south side of Main Street in Mackay, Idaho. Bricks, on the sidewalk, fell from the false store front of the unknown establishment. The building with the gaping hole in the masonry store front, above the LLL Cafe sign, is the City Hall (see also Figure 36). Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 32.--Looking east along the north side of Main Street in Mackay, Idaho. On the sidewalk, the bricks are from the partially collapsed wall of Perks Bar. The building west of the parked ambulance is Mackay Drug. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 33.--Looking west along the north side of Main Street in Mackay, Idaho. Mackay Drug is in the foreground and the Custer Hotel, the last multi-story building, is in the background. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 34.--The Custer Hotel. Looking east on the north side of Main Street in Mackay, Idaho. The Lundberg residence and the utility building is in the foreground. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 35.--Partial collapse of the south wall of Perks Bar which is located on the north side of Main Street. Mackay, Idaho. The exterior building walls of Ken's Club showed no evidence of damage. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.

front windows in the masonry building front. It was a two-level masonry structure (fig. 31 and fig. 36).

Custer Hotel (north side of West Main): This three-story, brick building with a movie house at street level was built in 1915. The building was severely damaged by the partial collapse of the front and side walls (fig. 37). The chimney, on the east side of the Hotel, partially collapsed due to the collapse of the building wall. At the rear and on top of the Hotel, a 8- to 10-foot brick chimney remained standing (fig. 38). From our ground angle, the chimney appeared to be undamaged. The hotel was reported to have been vacant for the past 20 years.

Lundberg Residence (north side of West Main): This residence was located immediately west of the Custer Hotel. It was a two-story, wood-frame structure with plaster insets (on lath strips) adorning the exterior wall. These plaster insets were not cracked. The home was built in 1910 (fig. 39). According to Mrs. Lundberg, the inside of the house was not damaged. A few knick-knacks and some china dishes fell from shelves. The house had three brick chimneys. The chimney, at the front of the house, was reported to have twisted counter-clockwise about 15 degrees. The other two chimneys showed little damage. The wooden utility house, on the east side of the residence, was damaged by falling bricks from the Hotel (shown in fig. 34).

The stubs of two brick chimneys were visible at the roof line (shown in fig. 38) at a two-story, wood-frame house located behind the Lundberg residence.

Ivie's IGA Grocery (south side of West Main): The grocery store was in a single story, concrete block structure with a brick front. The metal awning, which was attached to the store front, was shaken down. The store front was extensively cracked; and bricks fell from the store front. Inside the store, very little damage was visible to the interior plaster-board walls. Pictures of the store, following the earthquake, showed that the aisles were filled with merchandise shaken down from the shelves. The store was opened for business, but customers entered at the rear of the store (fig. 40 and fig. 41).

Mackay Drug (north side of West Main): The building was a two-story, brick structure. The building walls partially collapsed. Inside the store, it was reported that the walls were separated at the corners. At the rear of the store, a concrete block chimney was split from top to bottom. On the east side of this building, the collapsed brick wall demolished a car (fig. 42). Note the hollow bricks that were used in the construction of the collapsed wall.

Lions Lodge Hall (north side of East Main): The stone front of the single-story lodge hall was pushed slightly out to the south (fig. 43).

The building to the west and adjacent to the lodge hall was a storage building. The building front was a combination of wood and masonry. The upper masonry half of the front fell. The west cinder block wall of the building, which was painted white with an advertisement for Michelin Tires,



Figure 36.--Mackay City Hall which is located on the south side of Main Street. The original earthquake damage and additional portions of the wall have been removed prior to the time this photograph was taken (see Figure 31).



Figure 37.--The Custer Hotel which is located on the north side of Main Street in Mackay, Idaho. The Lundberg residence is shown at the left of the Hotel. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 38.--The rear of the Custer Hotel. The brick chimney atop the Hotel did not appear to be damaged. The two-story, wood-frame house, located behind the Lundberg residence and to the right of the Hotel, lost two brick chimneys.



Figure 39.--The Lundberg residence which is located on the north side of Main Street in Mackay, Idaho. The home was not damaged. The front brick chimney, which has been removed, was reported to be twisted 15 degrees counter-clockwise. The other two brick chimneys showed little damage. The partially collapsed west wall of the Custer Hotel is shown above the Lundberg's roof line. The chimney at the rear of the Custer Hotel is the same chimney shown in Figure 38.



Figure 40.--Ivie's Grocery Store which is located on the south side of Main Street. Mackay, Idaho. The aluminium awning and support rods were shaken down. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 41.--Inside Ivie's Grocery Store in Mackay, Idaho. A view of the merchandise in the aisle as a result of the earthquake. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 42.—Partial collapse of the east wall of Mackay Drug which is located on the north side of Main Street. The car was demolished by the falling bricks. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.



Figure 43.--The Lions Lodge Hall (building with the star) and the adjacent storage building which is located on the north side of Main Street in Mackay, Idaho. The south wall of the Lodge Hall was pushed slightly outward. The masonry half of the storage building's store front fell.

was cracked from top to bottom. On the exposed south end of the wall, part of the masonry wall was missing (fig. 44).

Tri County Ranch Supply, Inc. (south side of East Main): The building was a one-story, masonry structure. The upper 5 rows of bricks along part of the east wall partially collapsed. The brick store front was moderately cracked. Some bricks were missing from the store front (fig. 45).

Western Store and OK Hardware (south side of East Main): The one-story, cinder block building was approximately 40-50 years old. An employee reported there was little damage to the inside of the store. The plaster-covered cinder block store front exhibited many minor cracks (fig. 46). The employee reported that large quantities of merchandise were shaken down from the shelves.

Friedl Residence (3 blocks west of the Custer Hotel on Main Street): The wood-frame, log-sided home, built in 1966, was set on a concrete foundation. The house or the masonry flue-lined chimney was not damaged (fig. 47). Mr. Friedl indicated that a few items fell. A moderate amount of glassware and dishes was broken. The furniture was not moved or overturned.

Mackay High School: The brick-wall structure, with cinder block interior walls, was built in 1954-1955. It was located two blocks south of Main Street. The chimney on the roof was cracked; and the custodian reported that it was necessary to tear it down. Inside the gymnasium, the west wall (near the ceiling) was separated about 4 inches from a concrete pier. The bricks in the exterior west wall were slightly displaced along the separation seam (fig. 48). The north wall of the gymnasium was also pushed outward, but not as severely as the west wall. Minor plaster cracks in the mortar seams of the interior walls were observed throughout the building.

Inside the school, the custodian reported that chair desks and chairs were overturned; and books were scattered on the floor in class rooms. In the library, large quantities of books were thrown down from the shelves, especially from shelves along the west wall. Some adjustable shelves fell. The frame of the wall unit was attached to the wall (fig. 49). A few suspended ceiling tiles fell in the library, but most of the tiles were displaced within the metal grid frame. A trophy case, in the center of the building, was not overturned; however, one trophy fell and broke which was on top of the trophy case.

The 12-year old auditorium, a prefabricated metal addition, was joined to the school building at the southwest corner. The suspended ceiling tiles were displaced; some tiles fell at the connection with the walls and at the front of the stage. The exterior walls of the auditorium were adorned with decorative brick-veneer sections. One brick-veneer section fell.

The custodian and the librarian were in the library at the time of the earthquake. The custodian indicated that he held on to the index file cabinet to steady himself. The librarian was walking very unsteadily toward the library exit.



Figure 44.--The west wall of the storage building shown in Figure 43. The wall was cracked from top to bottom. Some collapse of the wall where it connects to the store front. Mackay, Idaho.



Figure 45.--A view of the partially collapsed east wall of the Tri County Ranch Supply, Inc. Some bricks are missing from the cracked store front. South side of Main Street in Mackay, Idaho.



Figure 46.--The cracked, plaster-covered, cinder block store front of the Western Store and OK Hardware. South side of Main Street in Mackay, Idaho.



Figure 47.--The Friedl residence at the western end of Main Street in Mackay, Idaho. The home or the chimney was not damaged.



Figure 48.--A photograph showing the displacement of bricks in the exterior west wall of the Mackay High School gymnasium.



Figure 49.--A view of the fallen shelves and books from the west wall of the Mackay High School library. Photograph by Robert Bower of the Post-Register Newspaper, Idaho Falls, Idaho.

At the custodian's wood-frame house, some articles were shaken to to the floor from shelves; and some glassware and dishes were lost.

Mackay Cemetery: The moderate-sized and well-maintained cemetery was located about 1/2 mile east of town. Two tombstones were affected by the earthquake. One of the tombstones was a three-sectional stone. The top stone was twisted clockwise and offset about 1 and 1/2 inches to the northwest (fig. 50). The mortar cement was absent from the base of the twisted stone. The other gravestone was a low, broad three-tiered monument. The top stone overturned and fell toward the south. The fallen stone was held in place by two wooden pegs—one peg was broken (fig. 51).

It was generally indicated by the townspeople that 90% of the brick chimneys were damaged in the residential section of Mackay. The chimneys without flue-liners experienced the more extensive damage. These brick chimneys were generally associated with the older, wood-frame homes built between 1910-1915. Typically, these brick chimneys, whose bricks were without mortar; or those with weak mortar seams, were shaken down in various amounts--some down to the roof line. Some examples of chimney damage at these older homes on streets, which bordered Main Street, are shown in Figures 52 through 55.

Some well-mortared brick chimneys, without flue-liners, tended to be twisted, and occasionally offset at roof line. In one instance, a well-mortared brick chimney with a metal flue-liner was broken and offset at roof line (fig. 56).

It was observed that some homes had both cinder block and brick chimneys. As at Challis, the cinder block chimneys were attached to the wood-frame homes by a metal strap. Most of these chimneys were not seriously damaged. Typically, the chimney was pushed away from the house with minor cracks in the mortar seams. In many instances, the cinder block chimneys remained standing; whereas the brick chimneys were damaged to some extent (fig. 57 and fig. 58).

Miller Residence (1 mile northwest of Mackay on U.S. Alt. 93 43.925N., 113.627W.): The single-story, wood-frame house or brick chimney was not damaged. Furniture was not moved. Quite a bit of glassware and crockery was broken according to Mr. Miller.

Moore, Idaho

U.S. Post Office (U.S. Alt. 93): The Post Office was housed in a single-story, wood-frame, brick-veneer building. The wood sheathing under the roof overhang became separated (one spot only). The sheathing was nailed back in place. A metal filing cabinet vibrated back and forth, but the cabinet was not moved. No items fell. The swinging glass door, at the inside entrance to the Post Office, was observed to swing back and forth. The earthquake sound was described as similar to an exploding furnace. It was barely felt by the



Figure 50.--Mackay Cemetery. The top stone was twisted clockwise and offset 1 and 1/2 inches to the northwest. The mortar beneath the twisted stone was absent.



Figure 51.--Mackay Cemetery. The top stone overturned and fell toward the south. Note the two wooden pegs which held the fallen stone in place. One peg was broken.



Figure 52.--An older wood-frame residence in Mackay, Idaho showing damage to chimneys without flue-liners.



Figure 53.--The chimney bricks were shaken down to near roof line. The man on the roof is picking up the fallen bricks. Mackay, Idaho.



Figure 54.--A few bricks in the front chimney were slightly displaced (spread apart). The rear chimney did not appear to be damaged. Mackay, Idaho.



Figure 55.--The chimney to the right was shaken down. The left chimney was slightly twisted with the bricks displaced at the connection of the chimney base and the roof line. Mackay, Idaho.



Figure 56.--A view of an offset chimney with a metal flue-liner. The chimney without a flue-liner on the left side of the house is missing. Mackay, Idaho.



Figure 57.--The cinder block chimney beside the house was separated slightly from the house. Note the damage to the two brick chimneys on the roof. Mackay, Idaho.



Figure 58.--A cinder block chimney with a metal retaining strap. The brick chimney, beside the house, lost several tiers of bricks down to the roof line. Mackay, Idaho.

postmistress, but just enough to tell it was an earthquake.

Prichart Residence (2 miles northwest of Mackay on U.S. Alt. 93
43.936N.,113.639W.):

The single-story, brick residence (built in 1966) or the brick chimney with a clay flue-liner was not damaged. Mrs. Prichart reported that a few small knick-knacks fell, but they were not broken. Several stacks of glasses, stacked 3 or 4 high, fell to the floor from the top of the refrigerator. Insecticides, cans of paint, and oil cans were shaken off of metal shelves in a cinder block building behind her home. The shelf unit was not overturned.

Smith, Wyle Residence (1/2 mile southeast of Dickey on U.S. Alt. 93
44.120N.,113.898W.):

The one-story, wood-frame, brick-veneer house (built in 1959) was set over and bolted to a concrete basement. One tier of bricks from the well-mortared, flue-lined chimney was missing. A stone veneer-faced column, which separated his two-door garage, was pushed slightly outward at the top. It was not a load-bearing column.

The house moved from side to side. There was no sensation of up or down motion. Mr. Smith reported that he staggered inside the home and that he lurched from doorway to doorway in order to get outside. Outside, he experienced difficulty in walking or standing.

Inside the house, a 6-inch (long) plaster-board crack developed over a wall opening which led from the kitchen to the living room. The kitchen cabinets were cleaned out. Plates, he reported, were sailing out of the cabinets like dealt cards. The inside walls were "cleaned" of their hanging objects--small shelves which held knick-knacks, clocks, pictures, and mirrors. Heavy furniture was moved. An upright piano was moved across the linoleum floor. Most light furniture was overturned. The ceiling light fixtures were shaken down. In his basement, the concrete walls were not cracked. The pantry room was a total disaster--can and jar goods were dumped from the shelves; and many of the glass goods were broken. The shelves stayed in place. In the garage, many semi-heavy items were thrown into the center of the floor. The shelves were not attached to the wall. The shelves overturned.

The quake was preceded by a noise similar to a sonic boom followed by a sound resembling passing jets. He and his family slept outside in tents on Friday night (the day of the quake).

Directly across U.S. Alt. 93 a lake was created in the Thousand Springs Valley between Chilly Buttes and the Smith residence.

Mr. Smith reported a friend's experience as he was driving east on

Doublesprings Pass Road in a four-wheel vehicle. The truck started to shimmy, and the steering was pulling the vehicle toward the side of the road. He applied the brakes, but the vehicle continued to bounce toward the side of the road. Just as the driver was getting out of his vehicle, the fault scarp developed about 10 yards in front of the truck.

Seismic surveys indicated that the Smith's residence is 500 to 600 feet above bedrock.

Whitworth Residence (junction of U.S. Alt. 93 and Trail Creek Road 44.062N., 113.830W.):

The two-story, wood-frame home was set over a concrete basement. Several minor cracks occurred in the ceilings and walls over and near the door openings. Several pieces of light furniture, such as floor and table lamps were overturned in the living room. In two bedrooms, platform base beds were shaken apart and the slats were broken. In one bedroom, a 4-drawer chest-a-drawer was overturned. Large quantities of dishware and antiques were lost by breakage. The antiques were in a multi-shelf glass and wood cabinet on legs. The antique cabinet overturned. The glass was broken, but the wood cabinet was not damaged. A heavy upright piano, on castors, was moved away from the wall about 2 inches over a carpeted floor. Upstairs, the damage was not as severe as downstairs Mrs. Whitworth reported. No chimney. Water pipes leading into the house were broken.

The Western Area

The western area extended from Arco, Idaho; southwest to Picabo; and northwest to Stanley, Idaho.

Bellevue, Idaho

The intensity at Bellevue was estimated to be at the V level. The damage to Glenn's Grocery, which could be interpreted as an intensity VI, was downgraded because of the generally poor condition of the building. This was the only damaged building in town. The owner of Guffy's Grocery reported that a building, older than Glenn's Grocery, was not damaged.

Glenn's Grocery (corner of Oak Street and State Highway 75): The two-story, brick building was built in 1910. The brick chimney was reported to have been rotated. The owner pulled it down. Several bricks in the retaining wall, over the front door, were dislodged and shaken down. The front wall, where the telephone line enters the building, was reported to have pulled away from the building about 1 to 2 inches (unconfirmed). Inside the store, tea and jello boxes were shaken down from the shelves. People who

lived upstairs, over the store, reported that nothing fell.

Guffy's Grocery Store (corner of Oak Street and State Highway 75): The one-story, wood-front, cinder block building was not damaged. Plaster-board interior walls were not cracked. The building was constructed in the 1950's. The grocery was directly across the street from Glenn's Grocery. One plastic bottle of liquid fell.

U.S. Post Office (set back about 50 yards from State Highway 75): The single-story, wood-frame building with stone ornamentation was not damaged. Metal shelves clattered, but the shelf unit was not moved. Nothing fell. The noise that preceded the earthquake sounded like a big roar of wind.

The postmistress lived across the street, on State Highway 75, in a two-story, cinder block house. Nothing fell. Her husband had checked the stone chimney; and new cracks were not noted. The house was not damaged.

Carey, Idaho

U.S. Post Office (U.S. Highway 20): The Post Office, a one-story, frame building, was not damaged. The postmistress reported that she was not at the Post Office during the time of the earthquake. She reported that nothing was out of place inside the Post Office.

She indicated that two light chairs were overturned in her brick home; and dishes and glassware were not broken or shaken down.

Adamson's Tire Auto Supply Groceries and Hardware Store (U.S. Highway 20): This all-purpose business establishment was in a tall (high ceiling), one-story, cinder block building. Inside the store, a few items fell the owner reported. The north wall of the building originally had large plate glass windows. These windows were taken out and replaced by cinder blocks. The small cracks in the mortar seams were in the original wall above the cinder blocks which replaced the windows.

There was a slight offset crack, approximately 1/2-inch, in the cinder block wall where a storage building joined the original structure. This offset could not be confirmed as earthquake related damage.

Gannett, Idaho

Gannett Store and Cafe (on a connecting road between Bellevue and U.S. 20 at Picabo) The one-story, frame building was a combination of a grocery store, cafe/bar, and living quarters. The building and the two brick chimneys, according to the owner, were not damaged. Hanging objects swung; and pictures on the wall were askew. Nothing fell in store or in the living quarters.

Hailey, Idaho

The buildings on Main Street had either wooden or masonry false store fronts. The store fronts were not damaged.

Broyle's Drug (South Main Street or State Highway 75): The single-story, brick building, with plaster-board interior walls was not damaged. The employee reported some light sundrie items were shaken down from the shelves.

The employee reported that at her home nothing fell, but she definitely felt the quake.

Wood River Building Supply (South Main Street or State Highway 75): The single-story, wood building with a stone and wood front was not damaged. A few light hardware items were shaken down from shelves. An employee described the earthquake motion as "rolling".

The employee reported that she lived in a trailer house. Things came off the walls. The house, which remained on the blocking jacks, was not tied down.

Ketchum, Idaho

The lady Police Dispatcher reported that nothing fell at her house, but there was a definite rolling motion. The clock pendulum struck the glass in the clock case, but the glass was not broken.

The Dispatcher indicated that a chimney was reported to be damaged. A fan fell from a dinning room ceiling was reported at another residence.

Circle K Food Store (corner of 5th and Main): The building was a one-story, cinder block structure. A few wine bottles fell. The manager pointed out small cracks in the mortar seams at the wall and ceiling connection.

She lived in a trailer house. She reported the house really shook. She was thrown out of the bed. The trailer house stayed on the blocking jacks.

Golden Rule Market (corner of 1st and Main): The building was a wooden, A-frame structure with masonry-veneer columns. The building was not damaged. According to employees, some items fell in ever aisle. The shaking was described by the employees as "quite a bit". A lady in Hailey, Idaho reported that many items fell with some breakage at this market in Ketchum.

Obsidian, Idaho

Cheveron General Store (State Highway 75): The two-story, wood-frame building set on a concrete block foundation was not damaged. A few jar items fell and broke; wine bottles vibrated on shelves, but no bottles fell. There was a 10 second electric power outage. The store owner reported his well water was murkey for a while, but the well water cleared up.

A customer at the store reported that he heard groaning noises coming from the mountains west of Obsidian. He was sharpening a saw which was placed in a vice. The vice, which was attached to a 2 x 4, shifted. He assumed that the saw became loose in the vice and began to retighten it when he realized it was an earthquake.

Picabo, Idaho

General Store (U.S. 20 Highway): The one-story, wood-frame building on a cinder block foundation was not damaged. Six bottles of wine fell and broke. Paper goods, stacked several rolls high, were not disturbed; however, the rolls generally fell when shoppers walk by the owner reported.

Smiley Creek Lodge (24 miles southeast of Stanley on State Highway 75):

The one-story, A-frame, log building was not damaged. Electric power was out for a few seconds. The noise associated with the earthquake sounded like a heavy truck was approaching the building. Windows rattled; chandliers swung; and pictures vibrated against the wall. A few unstable grocery items fell from the shelves. No breakage.

Stanley, Idaho

Jerrys's Country Store (State Highway 75): The one-story, log cabin (on a concrete foundation) was not damaged. Some merchandise fell to the floor from one shelf. One bottle of wine in the cooler fell and knocked the cork out. The earthquake sound resembled a rushing wind. Electric power was out for approximately 10 seconds. Power lines were whipped up and down about 1 to 2 feet.

In Stanley, there were reports of dishware shaken off of the tables. At a garage, it was reported that a crack developed in a 2-foot thick concrete block wall (unconfirmed).

A man and wife, who were at the Country Store, reported that at their home dishes or knick-knacks were not thrown down or overturned. The wife reported it sure shook; and the husband reported it was an easy rolling motion. The husband's bronco automobile bounced up and down, but the wheels stayed on the ground. Telephone poles and trees swayed.

The Eastern Area

The eastern area extended from Arco, Idaho northeast to Terreton, Idaho.

Howe, Idaho

Little Lost Store (State Highway 22 and 33): A one-story, wood-frame building set on the ground was not damaged. Some items fell from the store shelves. Minor plaster cracks occurred at their home.

Church of Jesus Christ Latter Day Saints (State Highway 22 and 33): The tall, elongated, brick structure, which housed the sanctuary, was reported to have cracks at window corners and along the ceiling beams. The offices and Sunday school rooms in a single-story, cinder block building were not damaged.

Mud Lake, Idaho

Dalton General Store (State Highway 33): The one-story, cinder block building was not damaged. Nothing fell.

At his one-story, wood-frame home, several trophies fell. A son, who was in the shower, held on to the sides of the shower to stay on his feet. His sister, who lived in a basement apartment, reported that the walls appeared to be wavy. The concrete basement walls were not cracked.

Terreton, Idaho

U.S. Post Office (State Highway 33): The one-story, brick building on a concrete slab floor was not damaged. A mail scale rattled on a table. The postmistress definitely felt the quake, and she described the motion as "rolling".

At the postmistress residence, a two-story, wood-frame structure, most all of the 5 x 7 folder type pictures were knocked over or fell off the dresser. Hanging lamps swung; and wall pictures vibrated. Her sister, who was halfway up the stairs, held onto the handrail to remain on her feet.

Country Cash Store (State Highway 33): Some articles fell, but nothing was broken. The single-story, wood-frame store was not damaged.

Aftershocks

Although numerous aftershocks were felt in the immediate area of the epicenter, foreshock(s) were not felt by the residents. Some of the residents reported that a few of the aftershocks were strong, but most of the aftershocks were relatively mild.

The authors felt two aftershocks on Saturday afternoon, October 29, about 4 p.m. and 5:30 p.m., MDT. We were in Wyle Smith's basement when the 4 p.m. shock occurred. The sound was very sharp (like a rifle shot) followed by the sensation of a circular or rolling motion. The motion passed very rapidly. During the 5:30 p.m. shock, three USGS people were in a motel room in Arco, Idaho. The two people who were sitting barely felt the quake; the person who was standing did not. Later, we learned the 5:30 p.m. event had a 5.5 (mb) magnitude. The shock at 4 p.m. was not located by the USGS.

Comments and Observations

In an area which extends from Mackay to Dickey--the area closest to the epicenter, damage to the well-designed and constructed wood-frame or log-frame residences was slight to non-existent. Most masonry structures, chimneys, buildings, and store fronts suffered some damage. Chimney damage, especially at the rural residences and in the residential section of Mackay, was the dominant visible feature. The response of brick chimneys to the earthquake shaking was variable--the type of damage even varied between chimneys at the same residence. Chimney damage (rotated; twisted; broken, sometimes offset, at roof line; bricks shaken down and/or spread apart to some extent) appeared to be dependent on the mortar strength, the absence of mortar between bricks, and the presence or absence of a flue-liner. The damage to masonry buildings and chimneys was more severe at Mackay than at Challis. Window damage (cracked and/or broken out) was only found in Mackay.

Earthquake fountains (water spouts) are produced in an area where there is plenty of ground water by a strong earthquake; and a fountain is characterized by a continuous flow of water which gradually falls off as the shaking subsides (Richter, 1958). One of two known locations of the earthquake fountains occurred north of the epicenter in the area of Thousand Springs Valley at Chilly Buttes. The other location, southeast of the epicenter, was in the Big Lost River Valley. In addition to an aquifer that underlies the entire valley, the Thousand Springs Valley is an indication of ground water at or near the surface. The time duration of the spectacular water display from the earthquake fountains is unknown to the authors. The authors were in the area of the fountains, near Chilly Buttes, about 2 p.m. (MDT) on the day after the earthquake occurred. At this time, most of the fountains were quiescent. However, at the Clark residence, the remains of a water spout was gurgling water (see Clark report under the Chilly Buttes heading).

The sound, associated with the earthquake, was reported to resemble a sonic boom by some residents. The reason for the correlation is that the Mountain Home Air Force jets often brake the sound barrier over this area.

The residents estimated that the duration of shaking lasted 20 to 30 seconds. The lateral shaking was reported to be very strong; whereas the initial vertical motion was not generally noted by the residents.

Throughout the epicentral area, mobile homes which were not tied down were reported to have remained on their jacks or on other types of blocking techniques.

Intensity

Geologic effects, in the Modified Mercalli Scale (Wood and Neumann, 1931), suggests higher intensities than those intensities based on vibrational effects to structures, to objects, and on people. Although the geologic effects produced by this earthquake indicated an intensity of at least IX, there was a lack of damage evidence at the residences and to the structures in the epicentral area to support the higher intensity value. Based on the Modified Mercalli Scale (Wood, and Neumann, 1931); the vibrational effects at the surrounding residences suggests an intensity value of VII at Chilly Buttes; the vibrational intensity near Mackay Dam, as judged by the reports of Anderson, Prichart, and Miller, is estimated to be about VI; and a preliminary intensity value of VII is estimated for Challis and Mackay based on the observed level of damage. At Mackay--the largest community near the epicenter, partial wall collapse in some of the older buildings may be an indication that the intensity probably lies near the upper limit of an intensity VII.

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