

## Intensity Mapping

1. On October 28, 1983, central Idaho was shaken by the Borah Peak earthquake ( $M_s = 7.3$ ,  $M_w = 6.8$ ). The earthquake, the largest in Idaho history, was felt in all or parts of seven western states. It caused the deaths of two children in Challis, Idaho, and injured one woman in Mackay. The Idaho bureau of Disaster Services estimated the earthquake damage at \$12.5 million.

Included with this handout are a map of Idaho and results from a survey describing damage and earthquake effects at many communities in the affected area. Your assignment is to:

- a. Using the descriptions of personal observations and damage and the criteria in the Modified Mercalli scale as listed on p. 241 of Bolt's text, assign intensities to each community surveyed. Note those intensities in the margin of the text of descriptions next to the community name and underline the factors in the description used in assigning the value.
- b. Write the intensity near the community name marked on the map.
- c. Draw isoseismal lines (contours of equal intensity) to complete the isoseismal map.
- d. Conclude the assignment, with a one-page discussion on uses and limitations of intensity maps in general for engineering purposes. Discuss the accuracy of your intensity map and note major deficiencies.

## **Cities:**

**Idaho City, Midvale, and Missoula** - Many outdoors felt the earth shake; pictures knocked against the wall; a pendulum stopped.

**Palisades, Silver City, Helena, and Colfax** - Many people indoors felt the quake; swaying objects.

**Salt Lake City, Le Grande, and Great Falls** - Some felt it.

**Boise, Cascade, and Salmon** - Nearly everyone felt the quake. A few reports of fallen plaster and overturned furniture.

**Mountain Home, Pocatello, Twin Falls, Butte** - Nearly everybody felt the quake indoors; a few dishes fell and broke.

**Drewsey** – Several people indoors felt the quake, few reports of lamps swaying.

## **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.

## **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 toiletries 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 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 and 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.

## **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 home.

Huge boulders, which rolled down the slopes of the mountains in the northwest section of Challis, were spectacular. 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.

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. This vacant building was one of the older buildings in Challis.

IIOF Lodge on Main Street: The lodge hall was in a two-story wood-frame building. The brick chimney, without a flue liner, and 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.

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 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. 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. 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.

### **Dickey, Idaho**

Fulton Residence (44.134N, 113.905W): It was a one-story, log building with an attic that was originally built in 1880. 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 dish 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 and knick-knacks 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. 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 canned foods were thrown from the shelves with many of the glass goods broken. The airway 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.

Behind the Fulton residence, the trailer hitch of a piece of heavy farm equipment was shaken off the cinder block support. 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. 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 waterspouts occurred on their property during the 1959 Yellowstone earthquake, but these same areas were not reactivated during this quake. According to her, the waterspouts on their property formed a northeasterly trending line up to the waterspout 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. 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 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 fell.

### **Bellevue, Idaho**

The intensity at Bellevue was estimated to be at the level. The damage to Glenn's Grocery, which could be interpreted as an intensity 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.

### **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.

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.

City Hall (south side of West Main): A gaping hole occurred above the front windows in the masonry building front. It was a two-level masonry structure.

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 sidewalls. 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, an 8- to 10- foot brick chimney remained standing. 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. 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.

The stubs of two brick chimneys were visible at the roof line 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 storefront. 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.

Mackay Drug (north side 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. 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 punched slightly out to the south.

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

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.

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-converted cinder block storefront exhibited many minor cracks. 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. 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. 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 classrooms. 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. 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.



## **Hailey, Idaho**

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

Broyles 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 sundry 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 dining room ceiling was reported at another residence.

Circle K Food Store (corner of 5<sup>th</sup> 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 1<sup>st</sup> 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 every 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.

## **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.

### **Stanley, Idaho**

Jerry'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 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.