Nevada earthquake epicenters for the period from about 1852 to 1961 are plotted on the accompanying map. During this period 1,173 earthquakes with Nevada epicenters were felt, 586 others with Richter magnitudes above 4.0 were recorded and were probably felt by some residents, and approximately 220 were reported in non-specific terms (e.g. "several aftershocks were felt"). High seismicity of this region is indicated by the fact that on an equal-area basis, during the period 1934-1960, Nevada had the highest incidence of earthquakes of any of the conterminous United States.

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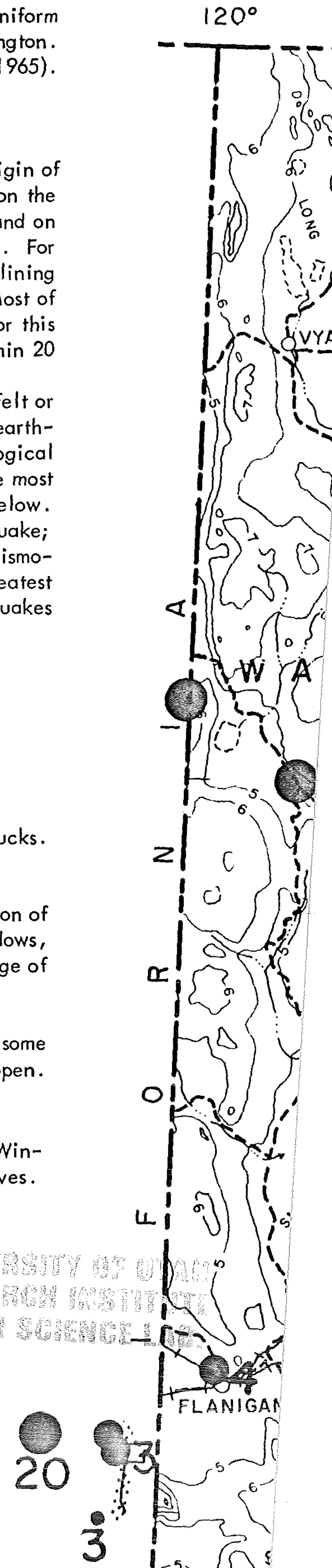
Data for this epicenter map is condensed from Slemmons, Jones, and Gimlett (1965).



TERMINOLOGY

Epicenter: The point on the earth's surface directly above the focus or origin of an earthquake. Accurate determination of an earthquake epicenter depends both on the number of seismographic stations which are located within the epicentral region, and on the accuracy of knowledge of the structure of the earth's crust in the same region. For larger earthquakes, it is possible to determine an approximate epicenter by outlining areas of greatest damage or areas where the earthquake was most strongly felt. Most of the epicenters plotted on this map have possible location errors of 5 to 15 miles; for this reason, epicenters for adjoining states are shown on the map only if they are within 20 miles of the Nevada boundary.

Intensity: A number assigned to each place where an earthquake is reported felt or does damage. The intensity at any point is indicative of the way in which the earthquake was felt, of the amount of damage it did to man-made structures, or of geological effects (e.g. surface faulting, landsliding) of the earthquake at that location. The most widely used scale is the Modified Mercalli scale, 1956 version, which is given below.

Richter magnitude: a measure of the amount of energy released during an earthquake; it is normally calculated from measurements on recordings made with calibrated seismographs. The greatest magnitude for any recorded earthquake is just under 9; the greatest for any Nevada epicenter is 7.75 for the 1916 Pleasant Valley earthquake. Earthquakes with magnitudes above about 5 or 5.5 are potentially destructive at the epicenter.

MODIFIED MERCALLI INTENSITY SCALE OF 1931, REVISED 1956 VERSION

I. Not felt. Marginal and long-period effects of large earthquakes.

II. Felt by persons at rest, on upper floors, or favorably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frame creak.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., fall off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and weak masonry and adobe cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).

VII. Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to weak masonry and adobe, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry of ordinary quality. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

...ffected. Damage to masonry of ordinary objects quiver. Furniture broken. Damage to weak masonry and adobe, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry of ordinary quality. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

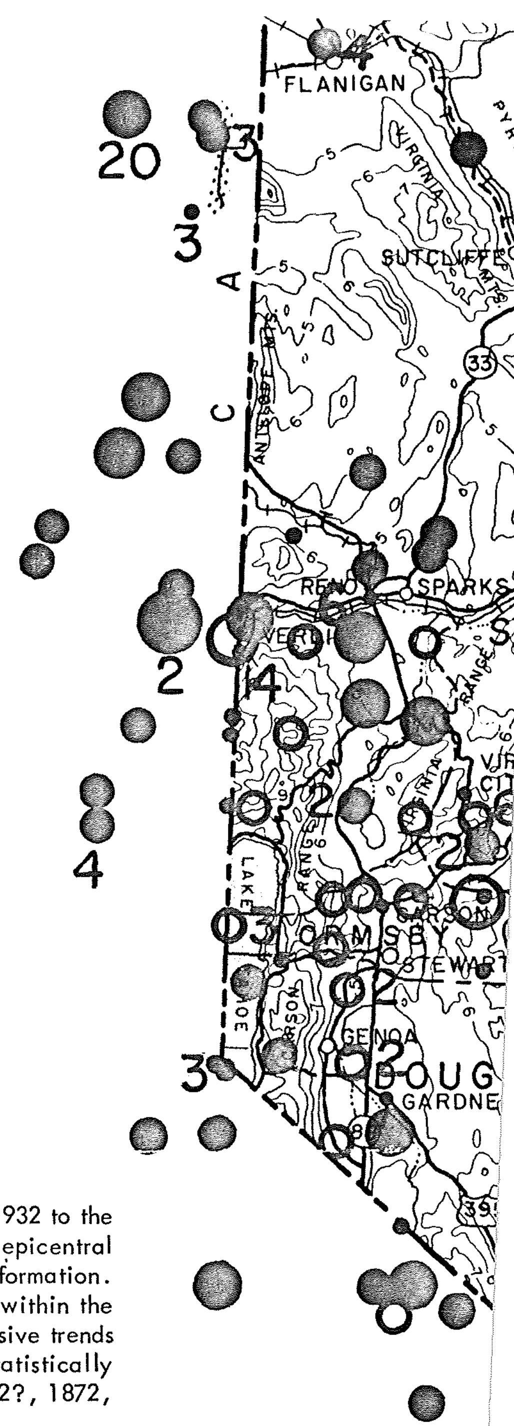
VIII. Steering of motor cars affected. Damage to masonry of ordinary quality, some damage to good masonry not designed to resist lateral forces, but none to well-constructed masonry designed to resist lateral forces. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX. General panic. Weak masonry destroyed; masonry of ordinary quality heavily damaged, sometimes with complete collapse; good masonry, not designed to withstand lateral forces seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frames cracked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand craters.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown out on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI. Rails bent greatly. Underground pipeline completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.



EPICENTRAL DISTRIBUTION

On this map, epicenters are divided into two groups -- pre-1932, and 1932 to the present -- in order to distinguish between early historic events with poor epicentral locations, and modern events with better epicenters based on instrumental information. A search of the data for periodicity or sequential relationships of activity within the province or with respect to adjoining provinces, has not revealed any conclusive trends of earthquake strain release in space or time, other than a distinct, but statistically inadequate tendency for a 20-year cycle of activity, with peaks at about 1852?, 1872, 1894, 1916, 1932-33, and 1954 (Slemmons, Jones and Gimlett, 1965).

Felt reports are naturally biased toward population centers. Except for Las Vegas, most of the larger towns (and even the old mining camps) are in western Nevada. Until recently most of the seismographic stations in the area have been on the west side of the State. During the late 1880's and early 1890's the Weather Bureau operated a pendulum seismograph in Carson City. The epicenters are biased toward Carson City for this period. Because of the Wiechert seismograph at the University of Nevada, epicenters are strongly slanted toward Reno for the period 1916-1932. A very large number of small events were felt and recorded at Boulder City during the late 30's and early 40's. Earthquakes began to be felt near Boulder City after Lake Mead had first filled to an elevation of 1,025 feet above sea level from a Colorado River level of 650 feet (Jones, 1944), and this activity has continued into the 1950's.

It is quite obvious that this map cannot be complete. However, it is believed that no events of magnitudes over 6.0 have been missed since approximately 1860. The epicenters include all known events with felt reports, and all instrumentally-determined events over 4.0 magnitude.

The general pattern for both periods of time is similar, with the exception of new, unusual activity near Lake Mead following the reservoir loading in 1936. The earlier events have a more rectilinear, grid-like distribution, due to epicenter locations which were rounded-off to nearest degree, half-degree, or quarter-degree. The distribution of epicenters is very uneven with a strong tendency for most of the activity to be in belts or areas of high activity with larger, intervening areas of weak seismic activity. The largest area of low earthquake activity is in eastern Nevada and western Utah. ... for many fresh-appearing geoevents have a more rectilinear, grid-like distribution, due to epicenter locations which were rounded-off to nearest degree, half-degree, or quarter-degree. The distribution of epicenters is very uneven with a strong tendency for most of the activity to be in belts or areas of high activity with larger, intervening areas of weak seismic activity. The largest area of low earthquake activity is in eastern Nevada and western Utah. There is an anomalous relationship for parts of this area, for many fresh-appearing geologically young faults and steep and rugged fault-block mountain ranges are present in this region. Evidently, the one-hundred year period of earthquake observation is statistically a very poor sample of the longer-term seismic activity of this region.

The epicenter map for Nevada shows a strong concentration of activity into the following three seismic zones, the first two of which cross each other in the Cedar Mountain—Excelsior Mountain area:

(1) Western Nevada-Eastern California Seismic Zone: This is a broad zone, about 50 to 100 miles wide, bounded on the west by the Sierra Nevada and on the east by faults at the eastern edge of the Walker Lane. The zone is structurally relatively narrow at the northern end near Reno, and broadens southward into two main sub-parallel structural branches, the Fish Lake Valley—Furnace Creek—Death Valley fault systems, and the Walker Lane (The Pyramid Lake—Walker Lake—Las Vegas Valley alignment). The zone has been especially active during the entire period for which records are available, and has been the site of at least 6 of 21 historic earthquakes which have produced surface faulting in the period from 1932 to the present. Although the heavier concentration of population in cities and towns located on or near the Walker Lane tends to bias felt reports toward this region, the concentration in the zone, both of very large earthquakes and instrumentally-determined epicenters, indicates that earthquake frequency and strain release are actually quite high in this region (see also Niazi, 1964). Although few fault-plane solutions are available for earthquakes in this region, the data from the Fairview Peak and Fallon—Stillwater earthquakes of 1954, and the direction of horizontal components of offset during the Cedar Mountain earthquake of 1932 and the Excelsior Mountain earthquake of 1934, indicate that many earthquakes in the zone have major strike-slip components of displacement that are right-lateral (dextral) on northerly to northwesterly trending faults, and left-lateral (sinistral) on northerly to northeasterly trending faults. The southeastern part of the zone, between Goldfield and Las Vegas, has a much lower intensity of activity, which indicates that recent tectonic activity there is mainly west of this zone on the Sierra Nevada fault zone, and on the Fish Lake Valley—Furnace Creek—Death Valley fault zones. Most of this area of activity is well within California (see Calif. Dept. of Water Resources, 1964) and is not shown on this map. The area contains most of the Pleistocene volcanics of the region. Note, for example, the Nevada distribution of cinder cones (Horton, 1964).

(2) The 118° Meridian Seismic Zone: This zone of activity includes the Owens Valley—Sierra Nevada fault zone (with surface faulting in 1872), and the Excelsior Mountain zone of 1934, the Cedar Mountain zone of 1932, the two Rainbow Mountain fault zones of 1954, the Fairview Peak and Dixie Valley earthquakes of 1954, the Wonder earthquake of 1903, and the Pleasant Valley zones of 1915. This zone is marked by strong strike-slip components of faulting at and near the Walker Lane, and mainly by normal faulting with subordinate strike-slip faulting at the north end of the zone. It includes 9 of 21 examples of historic surface faulting in the conterminous United States, and must be ranked as one of the country's most active seismic zones.

This zone, at least in part, follows the boundary between Sierra Nevada type granitic basement terrains to the west, and the mainly metamorphic terrains to the east. In the Walker Lane area it is related to a marked thickening of the earth's crust which extends westward toward the Sierra Nevada. It is also close to zones of intense mercury (Lawrence and Wilson, 1962) and antimony (Lawrence, 1962) mineralization. This suggests that the high level of seismic activity may be part of a long-term crustal instability that also influenced the distribution of the geologically-young mercury and antimony mineralization.

(3) The Southern Nevada Transverse Zone: This zone crosses southern Nevada on a structural line that begins on trend with the Garlock fault zone in the west, and curves northeastward to connect with the active earthquake belt in central Utah. This zone is of lower seismic intensity, except for a region near Lake Mead which became seismically active after reservoir loading commenced in 1936. Geologically, there is evidence for strong strike-slip components in east-west trending zones that are similar to the left-lateral faulting of the Garlock zone, and for right-lateral faulting along trends parallel to the Walker Lane.

EARTHQUA