WESTERN STATES SEISMIC POLICY COUNCIL
POLICY RECOMMENDATION 21-3

Definitions of Recency of Surface Faulting for the Basin and Range Province

Policy Recommendation 21-3

WSSPC recommends that each state in the Basin and Range Province (BRP), through consultation with state and federal geological surveys and other earthquake-hazard experts, define scientifically and societally relevant categories for recency of surface faulting (generally produced by magnitude ≥**M** 6.5 earthquakes).

WSSPC further recommends that in the absence of information to the contrary, all Quaternary faults be considered to have the recency of activity documented in the U.S. Geological Survey (USGS) *Quaternary Fault and Fold Database of the United States* until more adequate data can be developed.

Executive Summary

Fault recency definitions are limited to the Quaternary because this period of geologic time is considered by the geosciences community to be most relevant to paleoseismic investigations of earthquake faults (Machette and others, 2004). The Quaternary period began 2.58 million years ago and includes the Pleistocene epoch and Holocene epoch, which began 12,000 years ago and continues to present (https://www.geosociety.org/documents/gsa/timescale/timescl.pdf). The recency class of a fault is the youngest class based on the demonstrated age of the most recent surface faulting.

The establishment and definition of surface-faulting recency categories are based on the ways that faults are portrayed on geologic maps and on the availability of geologic data in the Basin and Range Province (BRP). Policy makers (owners, regulators, governmental agencies) should consult with state and federal geological surveys and other earthquake-hazard experts in using these recency categories and additional geologic data in developing definitions of hazardous faults to be considered in planning for development and infrastructure projects.

Examples of categories that are applicable for much of the BRP include the following:

Latest Pleistocene-Holocene fault – a fault whose movement in the past 15 ka has been large enough to break the ground surface.

Late Quaternary fault – a fault whose movement in the past 130 ka has been large enough to break the ground surface.

Quaternary fault – a fault whose movement in the past 2.6 Ma (Cohen and Gibbard, 2010) has been large enough to break the ground surface.

Background

The BRP is a large extensional to transtensional tectonic domain that contains thousands of normal-slip and a lesser number of strike-slip Quaternary faults involved in geologically recent deformation. Large earthquakes in the BRP, especially those associated with surface rupture, have occurred on faults with a wide range of recurrence intervals (time between successive surface-faulting earthquakes) and times since their most recent surface-faulting earthquakes. Many of the historic surface-faulting earthquakes in the BRP have ruptured multiple, distributed fault strands at the surface, which in some cases had significantly different geologic histories.

The tectonic behavior of Quaternary faults in the BRP differs from the more localized, higher slip-rate, chiefly strike-slip tectonics typical of plate boundary systems (e.g. California). These differences often warrant different approaches within the BRP when categorizing recency of surface faulting. The examples of fault recency categories in this policy recommendation are considered appropriate for much of the BRP, and depend on whether the fault offsets, or is covered by, geologic materials of different ages. The recency categories are described in more detail below.

A **latest Pleistocene-Holocene** criterion (≤15 ka) for recency of faulting is based upon recognition of faulting in deposits known to be ≤15 kyr old, which are widespread throughout the BRP. These deposits are temporally similar to, or post-date, the last glacial maximum, and include well-dated pluvial lake deposits (e.g. Lake Bonneville; Lake Lahontan) or glacial moraines (Pinedale or equivalent) and alluvial fans, including their associated outwash deposits. Geologists recognize these distinctive stratigraphic and geomorphic features associated with these deposits without recourse to costly dating techniques. The latest Pleistocene-Holocene criterion conforms to usage in the USGS *Quaternary Fault and Fold Database of the United States* (http://earthquake.usgs.gov/hazards/). However, because major historical earthquakes have occurred in the BRP on faults that do not show surficial evidence of previous latest Pleistocene-Holocene activity, the latest Pleistocene-Holocene span of 15 kyr is too short to encompass the range of average earthquake recurrence intervals on faults in the BRP.

A **late Quaternary** criterion (≤130 ka) for recency of faulting uses the onset of the Sangamon interglacial period as a datum and spans many of the average fault recurrence intervals in the BRP. All but possibly one of the historical surface-faulting earthquakes in the BRP (1887 Sonoran earthquake; Bull and Pearthree, 1988; Suter and Contreras, 2002) occurred on faults that show evidence of late Quaternary activity.

The **Quaternary** criterion (≤2.6 Ma) for recency of faulting represents the onset of a major climatic change to the current cycle of glacial and interglacial intervals, during which most of the surficial deposits and much of the present landscape formed in the BRP. All historical surface-faulting earthquakes in the BRP occurred on faults that show evidence of Quaternary surface faulting. The Quaternary recency of activity criterion encompasses the average recurrence interval for essentially all faults that might produce future surface-faulting earthquakes (≥**M** 6.5) in the BRP.

Recency of Faulting, Fault Activity, and Seismic Hazard

The examples of recency of faulting categories in this policy recommendation are intended to fulfill the needs of a broad spectrum of users involved in evaluating, regulating, and mitigating earthquake hazards in the BRP. Categories based on recency of faulting use easily obtained observational data and, as such, represent a first step toward defining fault activity or seismic hazard associated with faults. Future large, surface-rupturing earthquakes in the BRP most likely will occur on faults that display evidence of prior surface faulting during the late Quaternary (≤130 ka), and almost certainly on faults that display evidence of prior faulting during the Quaternary (≤2.6 Ma). Evaluation of fault activity and seismic hazard should consider timing of the most recent surface-faulting earthquake and a well-constrained average recurrence interval and/or slip rate spanning multiple paleoearthquake cycles (McCalpin, 2009). Whether a fault within a particular recency category constitutes a hazard or not depends on the time frame of concern, the elapsed time since the most recent event, and the size and frequency of future earthquakes.

Appropriate recency of faulting criterion allows policy makers to develop guidelines for identifying potential surface-rupture and ground-motion sources and evaluate the seismic hazards they present to specific communities and infrastructure. Elapsed time since the most recent large earthquake and average earthquake recurrence intervals are critical paleoseismic parameters when determining fault activity, but those data must be evaluated in conjunction with other considerations related to type of facility, societal constraints (level of acceptable risk); and goals, costs, and benefits of risk reduction (Lund and others, 2016) when assessing seismic hazard. It is then up to policy makers in each state to decide what recency category constitutes a hazardous or active fault and what level of seismic risk is acceptable.

References

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Assessment

The success of this policy recommendation can be assessed based on the use of these recency of surface-faulting categories by states and local governments to guide development of appropriate regulations and ordinances to mitigate seismic hazards. Utah, Colorado, and Clark County, Nevada have adopted an earlier version of WSSPC fault-activity categories; however, the recency of surface-faulting categories in this policy recommendation differ significantly from some earlier versions. Recency of surface faulting categories do not equate directly with seismic hazard, and policy makers must determine what frequency and size of future earthquakes represent a hazard to a proposed activity or facility significant enough to mitigate. A periodic re-evaluation of federal, state, and local governments should be made to determine the extent to which these definitions are being used to develop future seismic-hazard rules, regulations, and guidelines.

History

- WSSPC Policy Recommendation 18-3 was first adopted November 7, 1997 as WSSPC Policy Recommendation 97-1 by unanimous voice vote of the WSSPC members at the WSSPC Annual Meeting in Victoria, British Columbia.
- Re-adopted as WSSPC Policy Recommendation 02-3 by unanimous voice vote of the WSSPC members at the Annual Business Meeting September 18, 2002 in Denver, Colorado.
- Revised and re-adopted as WSSPC Policy Recommendation 05-2 by unanimous voice vote of the WSSPC members at the WSSPC Annual Business Meeting September 12, 2005 in Boise, Idaho.
- Revised and re-adopted as WSSPC Policy Recommendation 08-2 by unanimous voice vote of the WSSPC members at the WSSPC Annual Business Meeting April 22, 2008 in Seattle, Washington.
- Updated and re-adopted as WSSPC Policy Recommendation 11-2 by unanimous voice vote of the WSSPC members at the WSSPC Annual Business Meeting April 4, 2011 in Boise, Idaho.
- Permitted to sunset at the WSSPC Annual Business Meeting July 21, 2014 in Anchorage, Alaska, to facilitate a thorough review and revision of WSSPC's surface-faulting activity definitions for the BRP.
- Revised and re-adopted as WSSPC Policy Recommendation 15-3 by unanimous voice vote of the WSSPC members at the WSSPC Annual Business Meeting April 24, 2015 in Pasadena, California.
- Revised and re-adopted as Policy Recommendation 18-3 by unanimous voice vote of the WSSPC members at the Annual Business Meeting May 4, 2018 in Seattle, Washington.
- Revised and unanimously re-adopted as WSSPC Policy Recommendation 21-3 during the 2021 Annual Business Meeting.