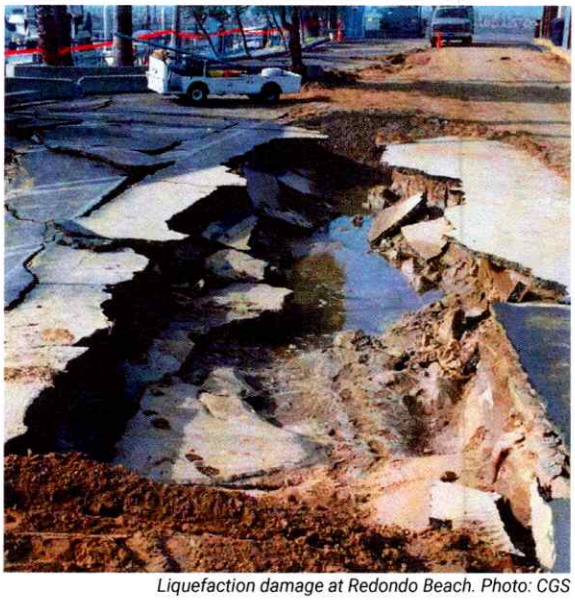
Damage to Redondo Beach from the 1994 Northridge Earthquake. Photo: CGS

CGS studies earthquake hazards to help Californians plan and build earthquake-resistant communities

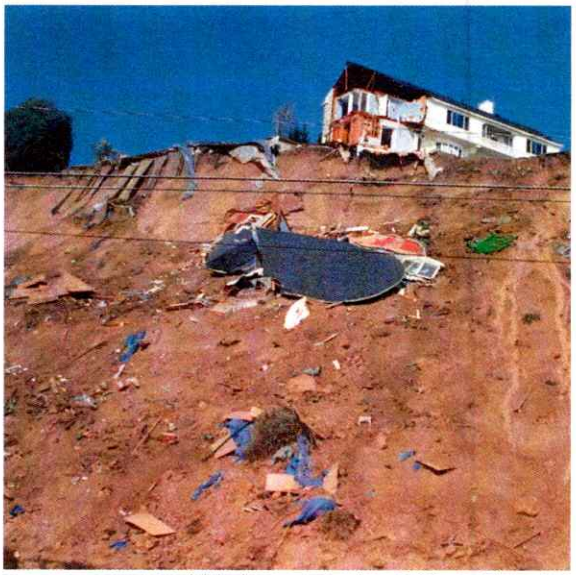
The California Geological Survey (CGS) establishes zones that delineate areas where ground failure due to liquefaction, landslides or surface fault rupture is more likely to increase earthquake damage (the hazard of strong earthquake shaking is addressed separately by the California Building Code). These areas are commonly referred to as "Earthquake Zones of Required Investigation" (EZRI).

Cities and counties are required by state law to withhold building permits within these zones until geologic/geotechnical investigations are conducted to assess seismic hazards on a site-specific basis. If a liquefaction or earthquake-induced landslide hazard is identified, appropriate design and/or ground improvement measures must be applied in order to reduce the potential for structural failures. Additionally, proposed structures must not be built across the trace of an active fault.

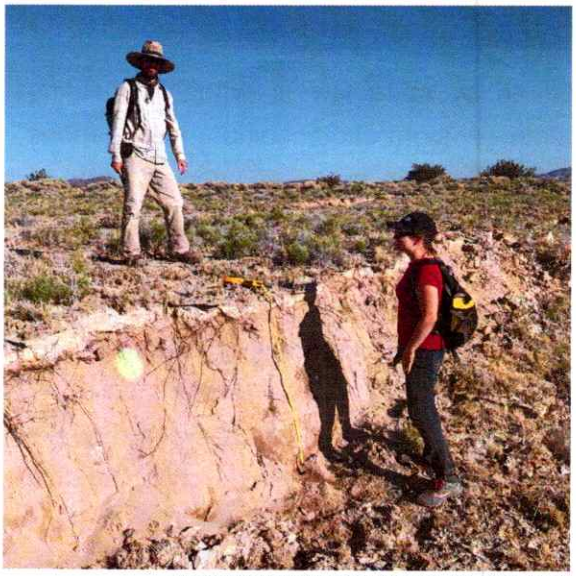
In all cases, sellers of real property are required to check earthquake zone maps produced by CGS to determine whether property being sold falls within a seismic hazard zone or earthquake fault zone. The seller is required to provide a "Natural Hazard Disclosure Statement" to the buyer.



Liquefaction damage at Redondo Beach. Photo: CGS



Landslide damage in Southern California. Photo: CGS



Surface fault rupture in Ridgecrest, CA. Photo: CGS

Earthquake-Induced Ground Failure Hazards:

LIQUEFACTION

Liquefaction, as a geologic term, refers to the loss of strength of saturated soils during shaking. An earthquake can cause soil particles to shift and lose contact with one another as increased water pressure in the pore spaces pushes them apart, resulting in their weakened ability to support structures. Liquefaction caused by the 1994 Northridge earthquake resulted in extensive damage to infrastructure, such as this Redondo Beach parking lot in the top photo.

LANDSLIDES

Landslides are the downhill movement of ground caused primarily by gravity acting on weakened rock or soil. Slopes are weakened by weathering, erosion, saturation, and the addition of weight in the form of artificial fill, structures, snow, or rock. Landslides that occur during earthquakes typically originate from these steep and weakened slopes. Numerous landslides occurred in the coastal bluffs and steep mountainous areas of Southern California following the 1994 Northridge Earthquake, destroying homes like the one shown in the middle photo.

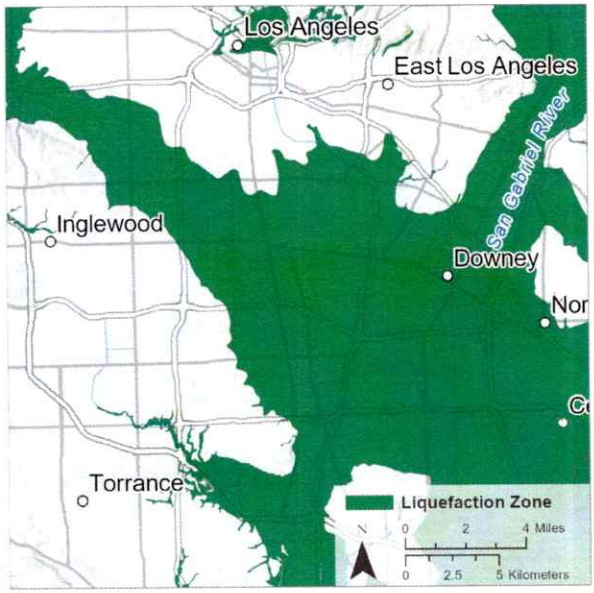
SURFACE FAULT RUPTURE

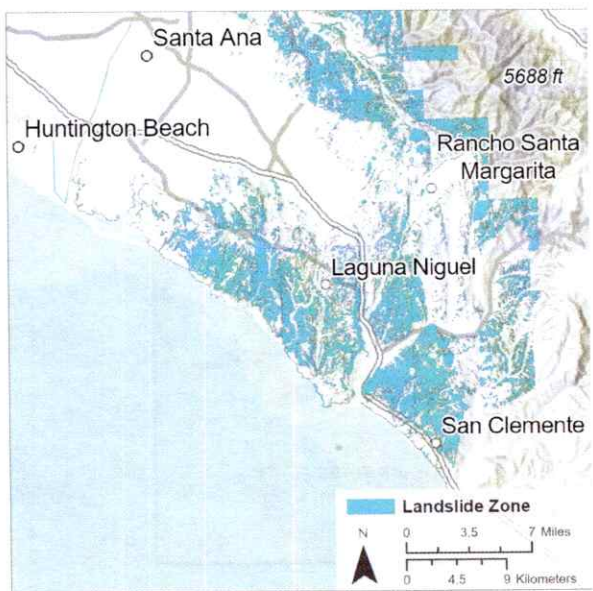
Surface fault rupture occurs when movement on a fault deep within the earth breaks through to the surface. Fault rupture almost always follows pre-existing faults, which are zones of weakness. Ruptures may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden ruptures are more damaging to structures because they are accompanied by shaking. There was over three feet of vertical displacement of the ground surface from the 2019 Ridgecrest Earthquake, as shown in the bottom photo.

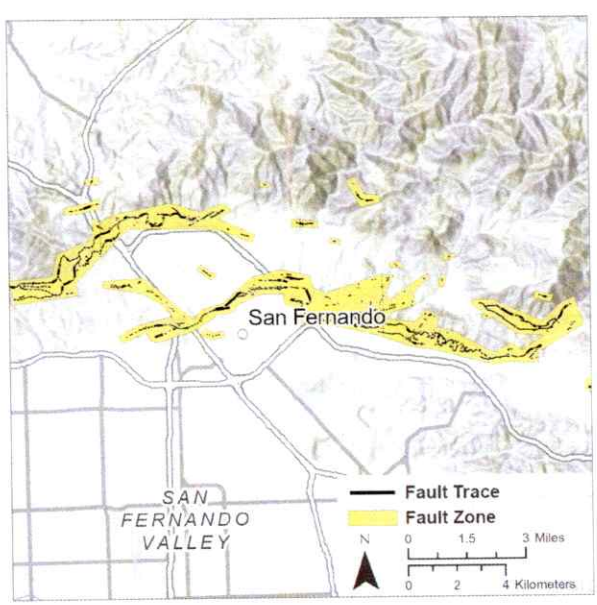
CGS geologists delineate liquefaction zones by assessing the engineering behavior of soils based on: surface geology and geomorphology; soil properties from subsurface borings; highest historical groundwater levels; and potential ground shaking from future earthquakes. Earthquake-induced landslide zones are delineated by mapping locations of existing landslides and analyzing rock strength, geologic structure, and surface topography in order to assess the stability of slopes under future earthquake shaking.

CGS has released over 100 official liquefaction and landslide zone maps covering thousands of square miles. These maps show zones of liquefaction and earthquake-induced landslides. The top figure shows a detailed map of the seismic hazard zones for potential liquefaction (in green) for South Los Angeles, whereas the middle figure shows the seismic hazard zones for potential earthquake-induced landslides (in blue) for a portion of Orange County. Ninety-two of the completed maps cover parts of Los Angeles, Orange, Ventura, San Bernardino, and Riverside counties; these seismic hazard maps are compiled into one map inside this CGS Note (page 4). CGS will continue producing earthquake zone maps for liquefaction and earthquake-induced landslides in southern California.

CGS geologists place earthquake fault zones around traces of faults where mapping demonstrates surface fault rupture has occurred within the past 11,000 years (Holocene time). Construction within these zones cannot be permitted until a geologic investigation has been conducted to prove that a building planned for human occupancy will not be constructed across an active fault. These site-specific investigations evaluate the location and recency of surface fault rupture and are typically based on observations made in trenches excavated across fault traces. The bottom figure shows an earthquake fault zone (in pale yellow) for a portion of the San Fernando fault zone that ruptured during the 1971 San Fernando Earthquake. CGS has released over 500 official fault zone maps statewide.

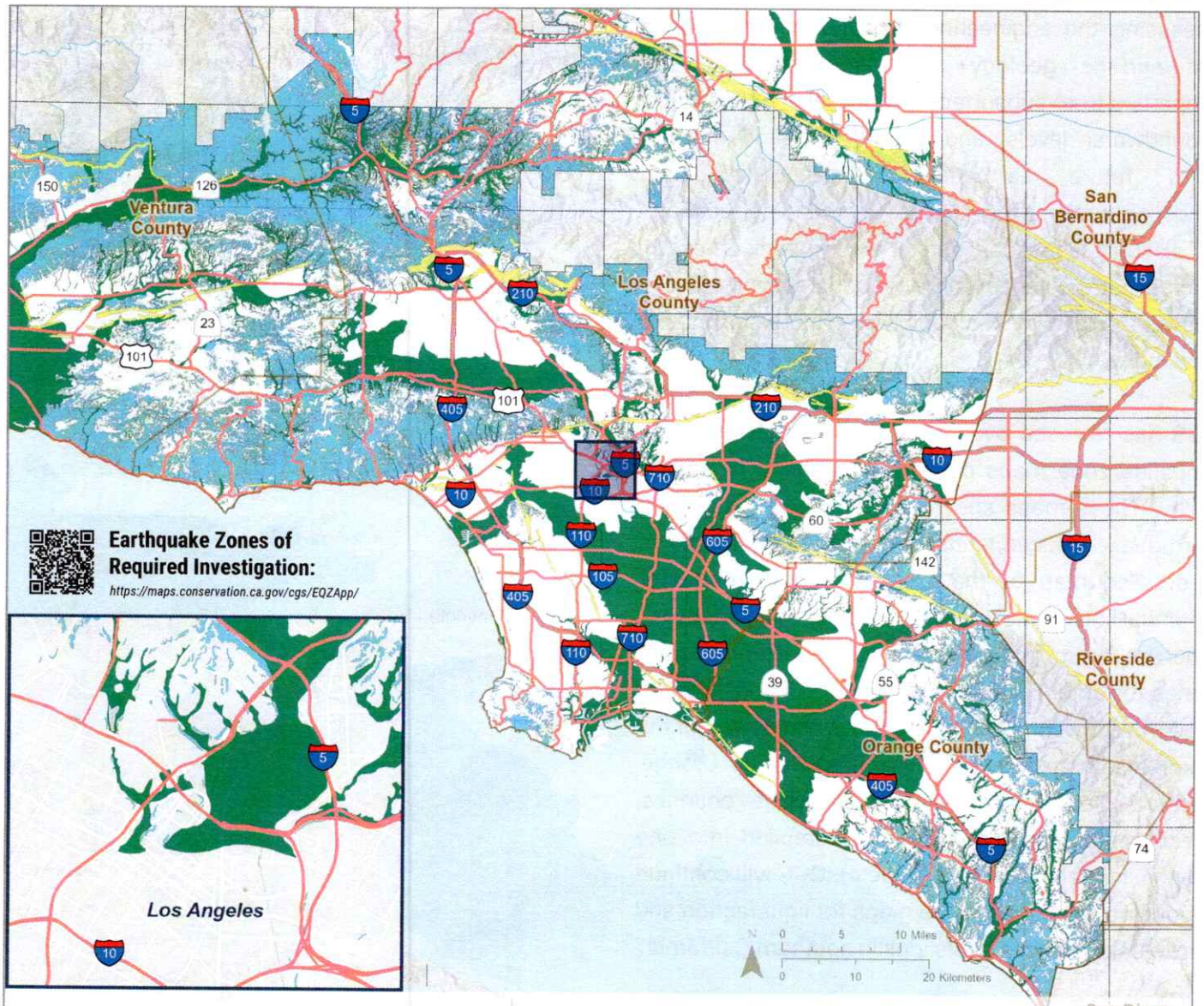






Seismic Hazard Zonation of Southern California

Current as of January 2023



MAP EXPLANATION

Earthquake-Induced Landslides
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and sub-surface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code 2963(c) would be required.

Liquefaction
Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Surface Fault Rupture
Regulatory zones encompassing active faults so as to define those areas within which fault-rupture hazard investigations are required prior to building structures for human occupancy.

Area Not Evaluated for Seismic Hazard Zones
Area has not been evaluated for liquefaction or seismic landslides because: it is not developable for significant structures for human occupancy in the foreseeable future; it is not anticipated to experience levels of earthquake shaking high enough to generate these hazards; or CGS plans to delineate hazard zones in the future but has not prepared maps at this time.

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