NEW LANDSLIDE MAPPING OF THE PITAS POINT AND VENTURA QUADRANGLES VENTURA COUNTY, CALIFORNIA

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NEW LANDSLIDE MAPPING OF THE PITAS POINT AND VENTURA QUADRANGLES, VENTURA COUNTY, SOUTHERN CALIFORNIA

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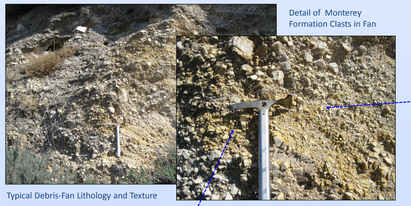
The California Geological Survey (CGS) recently completed new landslide mapping of the Pitas Point and Ventura quadrangles as part of the Seismic Hazards Zonation Program. These 1:24,000-scale maps will be published online in the CGS Landslide Inventory Map Series. The inventory maps were prepared by geomorphic analysis and interpretation of stereo-paired aerial photographs, LiDAR and NAIP imagery, on-line oblique photo-mosaics on Bing™, and topographic maps, as well as limited field observations and review of previous mapping. Landslide deposit and source (scarp) areas were digitally compiled and key attributes were assigned to each landslide.

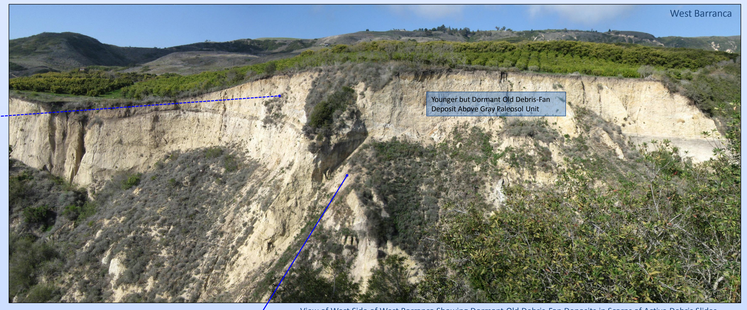
Landslides are a significant geologic hazard in the Pitas Point and Ventura area, having caused the disruption of the road and railway along the coast as far back as 1865, damage to oil wells along the Ventura Avenue-Rincon anticline trend, and the destruction of homes in the town of La Conchita in 1995 and again in 2005, when 10 lives were lost. Landslides are common throughout the area because it is underlain primarily by weak, fine-grained, sedimentary strata that have undergone rapid, late Quaternary tectonic uplift, folding, faulting and subsequent erosion, resulting in the development of steep-sided canyons and coastal bluffs. Landslides, including local earth flows, are most concentrated in the "Mud Pit shale." The distribution and failure mechanism of bedrock landslides are controlled primarily by the underlying geologic structure and its relationship to slope gradient and orientation. Translational and compound failures are dominant near fold axes and on dip slopes. Several large, dormant old landslides occur in the Sespe Formation on the flanks of the Red Mountain anticline. Rotational and wedge-type failures are the dominant mechanisms where neutral or antidip bedding is exposed in high steep slopes. Shallow debris slides and flows commonly develop in colluvium, weathered rock, and existing slide debris after periods of heavy rainfall, particularly in the Pico and Rincon Formations. Extensive Late Pleistocene debris deposits on the southwest side of Rincon Mountain are largely a combination of debris flow sheets and long-runout landslides that are unique in the area and have been designated as debris fans on the inventory map.

Younger Debris Slide Deposit in West Barranca



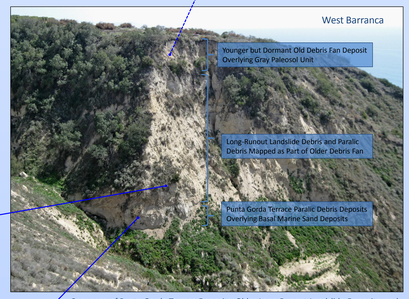
Detail of Monterey Formation Clasts in Fan

Typical Debris-Fan Lithology and Texture



View of West Side of West Barranca Showing Dormant Old Debris-Fan Deposits in Scarps of Active Debris Slides

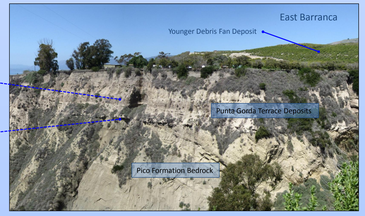
Example of folded but intact Monterey Formation bedrock



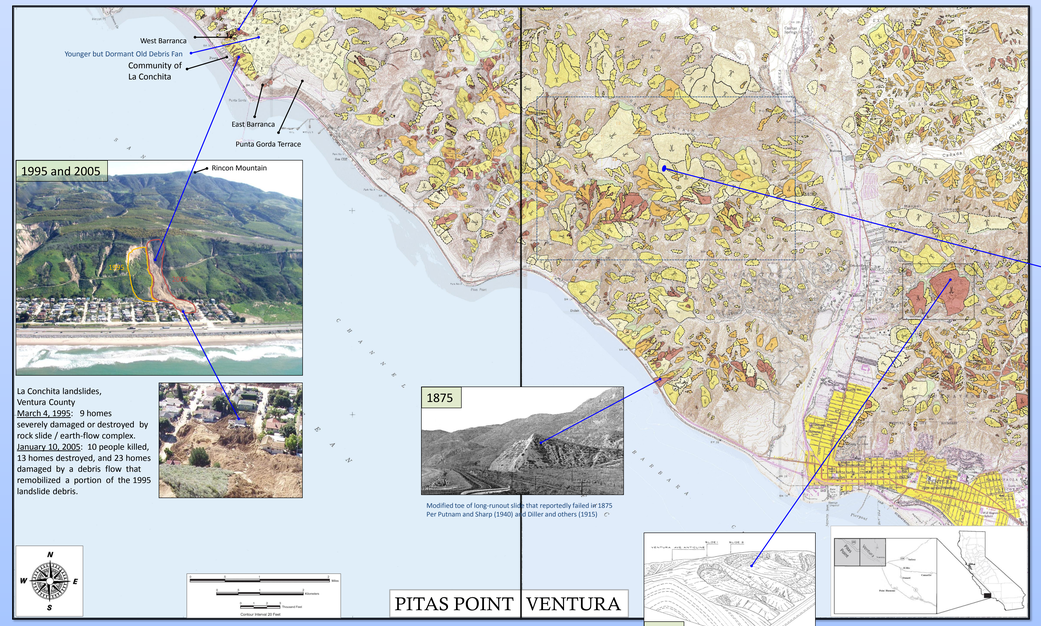
Sequence of Punta Gorda Terrace Deposits, Older Long-Runout Landslide Deposits, and Younger Debris-Fan Deposits Exposed in Scarp of Younger Landslide (View Southeast)

Long-Runout Landslide Debris Overlying Punta Gorda Terrace Deposits. Contact at Hammer

Crudely Bedded Punta Gorda Terrace Paralic Debris Deposits Overlying Basal Marine Sand Unit (Dated at about 45 ka)



Exposure on West Side of East Barranca Showing Intact, North-Dipping Pico Formation Bedrock Overlain by a Thin Layer of Friable to Indurated Marine Sand and Overlying, Crudely Bedded, Paralic Debris Deposits of the Punta Gorda Terrace. Younger, but Dormant Old, Debris Fan Deposits Overlie the Terrace Deposits in the Distance



La Conchita landslides, Ventura County
March 4, 1995: 9 homes severely damaged or destroyed by rock slide / earth-flow complex.
January 10, 2005: 10 people killed, 13 homes destroyed, and 23 homes damaged by a debris flow that remobilized a portion of the 1995 landslide debris.

Modified toe of long-runout slide that reportedly failed in 1875 Per Putnam and Sharp (1940) and Diller and others (1915)

Landslides in Ventura Avenue oil field reactivated in 1938 rains, per Putnam and Sharp (1940)

RINCON MOUNTAIN DEBRIS DEPOSITS - An extensive area southwest of Rincon Mountain is characterized by subdued terrain that has been mapped as underlain by either older alluvium (Dibblee, 1988) or Pleistocene mass wasting deposits (Tan and others, 2003). Reconnaissance field mapping and geomorphic analysis of this area indicates that it is underlain by debris-flow and intermixed long-runout landslide deposits composed of disrupted fragments of Monterey Formation derived from the Rincon Mountain area. Thick accumulations of debris-flow and/or hyperconcentrated-flow deposits typically consist of variable concentrations of pebble- to local boulder-sized, angular to subangular clasts in a silty matrix. Bedding is either lacking, crude or irregular. The intermixed long-runout landslide debris is characterized by highly disrupted, angular to deformed blocks of fractured Monterey Formation shale and sandstone with little or no silt matrix. Good exposures of this type of landslide debris overlying a thin section of Punta Gorda terrace debris are present in the West Barranca (see illustrations above). Significant accumulations of this debris observed northeast of Punta Gorda terrace on the northeast side of an apparent paleoshoreline sea cliff likely reflect failures resulting from wave erosion and associated over-steepening of the southwest flank of Rincon Mountain. The abrasion platform was reportedly abandoned at about 45 ka. A large, distinctive, younger (but dormant old) debris deposit located above and outboard of the paleoshoreline is well exposed in the upper walls of the West Barranca above a distinctive gray paleosol. This deposit still retains a distinctive fan geomorphic appearance and is therefore mapped as a debris-fan deposit. The older debris deposits northeast of the paleoshoreline are also mapped as debris-fan deposits, although the original fan geomorphology has been modified significantly by erosion. Gurrola and others (2010) have hypothesized the presence of a megaslide extending from Rincon Mountain to the southwest below the community of La Conchita. This slide is not shown on the current landslide inventory map based on field evidence that suggests that intact exposures of the basal sand of Punta Gorda terrace within the megaslide area are not unexpectedly low in elevation relative to the same northwest-tilted deposits exposed southeast of the megaslide and the lack of a cross-bedding failure mechanism below the Punta Gorda terrace abrasion platform.

GEOLOGIC UNITS AND LANDSLIDE SUSCEPTIBILITY

Saugus Formation – Pleistocene: Nonmarine fluvial/alluvial sandstone, conglomerate and mudstone; weakly indurated: **Susceptible to sliding**

Las Posas Formation – Pleistocene: Shallow marine sandstone and local conglomerate; weakly indurated: **Susceptible to sliding**

"Mud Pit shale" (Santa Barbara Formation) – Pleistocene: Basinal marine mudstone or claystone with local sandstone and conglomerate interbeds: **Highly susceptible to sliding**

Pico Formation – Pliocene and Pleistocene: Marine turbidite sequence consisting of basinal mudstone and siltstone with sandstone and local conglomerate interbeds: **Fine-grained units highly susceptible to sliding**

Sisquoc Formation – Miocene and Pliocene?: Marine silty shale or claystone; locally siliceous: **Susceptible to sliding**

Monterey Formation – Miocene: Marine siliceous and diatomaceous shale with fine-grained sandstone interbeds: **Susceptible to sliding**

Rincon Shale – Miocene: Marine shale and siltstone: **Susceptible to highly susceptible to sliding**

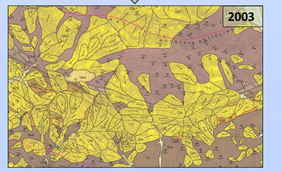
Vaqueros Sandstone: – Miocene: Marine sandstone; locally calcareous: **Generally resistant to sliding**

Sespe Formation – Oligocene: Nonmarine sandstone and pebbly sandstone with siltstone and claystone interbeds: **Susceptible to sliding**

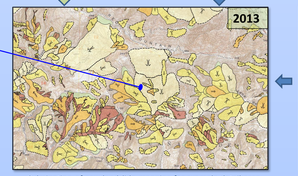
PREVIOUS LANDSLIDE MAPPING

Reconnaissance Photo-Interpretation Map: Weber & others (1973) 1:48,000

Geologic Map of Pitas Point and Ventura Quadrangles: Dibblee (1988)

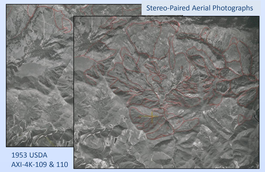


Geologic (and Landslide) Map of Ventura Quadrangle: Tan and others (2003)

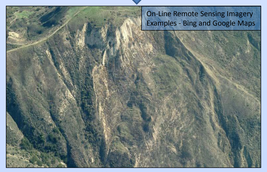


Culmination of new landslide mapping for example detail area, differentiating Landslide Deposits and Source Areas

GEOMORPHIC ANALYSIS



1953 USDA AXI-4K-109 & 110



Example of Bing Birds-Eye Oblique Imagery

2005 LiDAR (Active Slides Shown) 2005 NAIP Imagery

Landslide Debris Exposed in Road Cut

LANDSLIDE SOURCE

Recognizable scarp areas are shown with green shading

LANDSLIDE MATERIAL AND INITIATION TYPE

Landslides are designated based on a two part classification system that records the type of material and initiation type, per Cruden and Varnes (1996). Material Types are differentiated into either rock or soil and soil is further subdivided into "earth" or "debris" based on the cohesive properties of the soil, which generally correspond to the dominant grain size. There are five categories of Initiation Types: **slide, flow, fall, topple** and **spread.** The material type is combined with the initiation type to form the landslide designation, which is delineated on the map based on arrow style. The dominant landslide types in the study area are described below.

ROCK SLIDE:
Parent material includes formational bedrock

DEBRIS SLIDE:
Parent material consists primarily of low cohesion (granular) soil and/or pre-existing landslide debris

DEBRIS FLOW:
Parent material consists of low cohesion (granular) soil that has flowed; generally rapidly moving

EARTH FLOW:
Parent material consists primarily of cohesive (fine-grained) material; commonly slow moving

DEBRIS FAN:
Fan-shaped accumulation of low cohesion soil or rock breccia deposited by debris or hyperconcentrated flows or long-runout landslides;

LANDSLIDE INVENTORY MAP EXPLANATION

ACTIVITY

Landslides are classified according to how recently they have moved based on their relative geomorphic youthfulness. Four categories are defined based on the system of Keaton and DeGraff (1996), and are shown by color coding on the map.

ACTIVE or HISTORIC:
The landslide appears to be currently moving (at the time the aerial photograph was taken or field observation occurred) or to have moved within historic time.

DORMANT - YOUNG:
The observed landforms related to the landslide are fresh or un-eroded, but there is no evidence of historic movement.

DORMANT- MATURE:
The observed landforms related to the landslide have been smoothed and subdued by erosion and vegetation.

DORMANT - OLD:
The observed landforms related to the landslide have been greatly eroded, including significant gullies or canyons cut into the landslide mass and/or main scarp by small streams.

CONFIDENCE

A measure of the likelihood that the landslide exists based on the distinctiveness of observed landforms or outcrops. Delineated on map by line type based on the 3-fold system of Wieczorek (1984)

DEFINITE:
Landslide exhibits many of the diagnostic landforms, including, but not limited to, prominent scarps, open cracks, rounded toes, offset streams, well-defined mid-slope benches, closed depressions, springs, and irregular or hummocky topography, or has clear records of prehistoric, historic or ongoing activity from reports, aerial photography or instrumental monitoring.

PROBABLE:
Landslide exhibits several of the diagnostic landforms commonly associated with slope movement. These landforms may be modified by erosion or obscured by vegetation such that other explanations are possible. However the preponderance of evidence strongly suggests that a landslide does exist.

QUESTIONABLE:
Landslide exhibits only one or a few of the diagnostic landforms associated with slope movement. The landforms may be heavily modified by erosion, altered by grading, obscured by dense vegetation, or formed by other geologic processes such as differential erosion of lithologic and structural features in the underlying bedrock.