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THE HAYWARD FAULT - WE CAN'T IGNORE IT; A VIDEO TAPE, PART 1 ACTIVE FAULTS, EARTHQUAKE HISTORY AND HAYWARD FAULT TOUR

Open File Report 95-814-A

by

Sue Ellen Hirschfeld [1] *and Fred W. Klein* [2]

THE HAYWARD FAULT - WE CAN'T IGNORE IT; A VIDEO TAPE, PART 2 FAULT CREEP, EARTHQUAKE HAZARDS AND THE FUTURE

Open File Report 95-814-B

by

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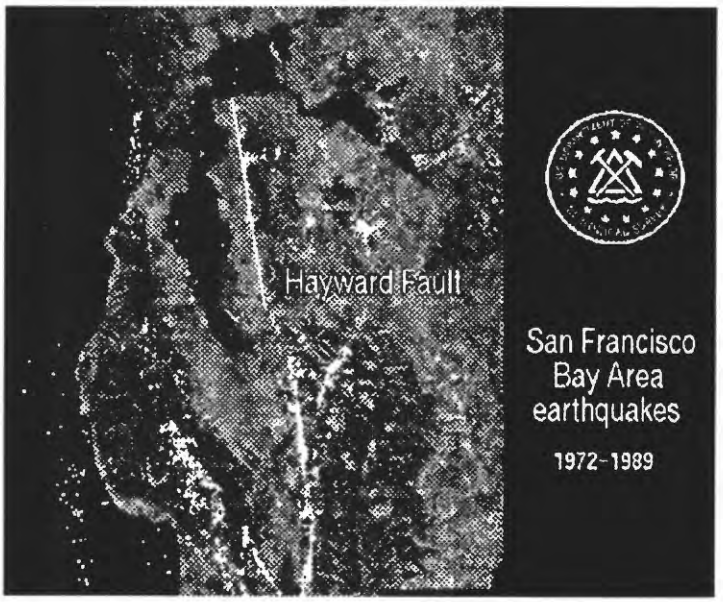

THE HAYWARD FAULT - WE CAN'T IGNORE IT

A VIDEO TAPE
PART 1: FAULTS, EARTHQUAKE HISTORY AND HAYWARD FAULT TOUR
PART 2: FAULT CREEP, EARTHQUAKE HAZARDS AND THE FUTURE

U.S. Geological Survey Open File Report 95-814

Produced by

U.S. Geological Survey, Menlo Park CA and
Department of Geological Sciences, California State University, Hayward

This videotape program concentrates on earthquake hazards on the Hayward fault and in the San Francisco Bay Area. Although there are numerous active faults in the Bay Area, the Hayward fault has become the center of attention because it is one of the most hazardous faults. The video tape is aimed at a general interest audience, including students from middle school to college. A printed report distributed with the tape contains suggestions for teachers in the classroom, a glossary and references.

Part 1 covers the basics of earthquakes and faults, faults and earthquake history in the Bay Area in California, includes a tour of notable features that can be seen along the Hayward Fault, illustrates landforms observable along the Fault, and features an animated flyover of the Fault.

Part 2 covers additional information on the earthquake history in the San Francisco Bay Area, examples of fault creep seen at the surface, how fault creep and locked patches occur together, earthquake probability, expected intensity of shaking, earthquake hazards, and practical ideas for preparedness.

OUTLINE OF PART 1 (29 MINUTES)

Note: The distribution tape contains both parts 1 and 2. Times are from the beginning of the tape. The tape is divided into sections, making it easy to view all or parts of the tape in one session.

1) 00:15 Introduction
2) 01:31 Earthquakes and faults
3) 03:25 The San Andreas Fault
4) 05:17 San Francisco Bay Area faults
5) 07:03 San Francisco Bay Area earthquake history - location of large events
6) 09:24 Historic Hayward Fault earthquakes
7) 10:58 Creep on the Hayward Fault (an introduction)
8) 12:04 Tour of the Hayward Fault - Fremont northward to San Pablo Bay
   12:40 Fremont, South Hayward, Downtown Hayward
   16:42 Oakland, Berkeley, San Pablo, Point Pinole
9) 19:30 Computer-generated flight along the Hayward Fault - introduction
10) 20:53 Landforms visible in the flight along the Hayward Fault
11) 24:40 Computer-generated flight along the Hayward Fault - the flight
12) 26:30 Conclusion to tape 1

OUTLINE OF PART 2 (33 MINUTES)

1) 29:15 Introduction
2) 30:39 San Francisco Bay Area earthquake history - timing of large events
3) 33:26 Earthquake probability
4) 34:47 Creep on the Hayward Fault
5) 38:40 Creeping and locked patches on the Hayward Fault
6) 42:42 Seismicity of creeping and locked faults
7) 44:33 Destructive ground shaking
8) 47:45 Earthquake hazards in the San Francisco Bay Area
9) 50:11 Earthquake hazards - soft soils and weak construction
10) 53:44 Earthquake hazards to utilities and lifelines
11) 56:49 Earthquake preparedness
12) 59:20 Conclusion to tape 2
    1:00:50 End

TAPE AVAILABILITY

Copies of the tape are available for loan to organizations from:

Library, Video section
U.S. Geological Survey, 345 Middlefield Rd., Menlo Park CA 94025
(415) 329-5009 FAX: (415) 329-5132 email: mmmoore@usgs.gov

Copies of the tape may be obtained from the following and possibly other sources.

KAKM Video, 3877 University Drive, Anchorage AK 99508 (800) 684-3368
(907) 563-7070, FAX: (907) 273-9192 KAKM accepts credit card orders.
VHS tape cost is $9 plus $4 shipping. Order weekdays from 9-5:30 Alaska time (10-6:30 Pacific time).

Instructional Media Center, Cal State Univ. Hayward, Hayward CA 94542.
Phone (510) 885-3692; Fax (510) 885-3953. $19.95 for VHS tape with
color cover and 6-page report, including tax, shipping and handling.

INTRODUCTION

Say the word earthquake and most people think of California. Earthquakes can occur throughout the United States, but most are too small to be felt. The frequency of large earthquakes in the eastern part of the United States is much lower than in the West. But, when a large earthquake occurs in the East, damage can be extensive over a very wide area.

This two-part videotape program concentrates on the San Francisco Bay Area in central California and on the Hayward fault. Although there are numerous active faults in the Bay Area, the Hayward fault has become the center of attention because it is one of the most hazardous faults. This is due to the concentration of population living and working in proximity to the fault and because it is the one with the highest probability of producing a disastrous earthquake in the near future. The Hayward fault is also an ideal fault to study because it is easily accessible along it's entire length and it displays most of the characteristic surface features found along active faults. The principles described and illustrated for the Hayward fault apply to other faults and other areas of the country.

The video tape is aimed at a general interest audience. Part 1 is for a more basic audience and part 2 includes more scientific ideas. In terms of educational level, part 1 is suited to middle school to college level, and part 2 is more suitable for high school and college students.

Part 1 covers the basics of earthquakes and faults, faults and earthquake history in the Bay Area in California, includes a tour of notable features that can be seen along the Hayward Fault, illustrates landforms observable along the Fault, and features an animated flyover of the Fault. The videotape is appropriate for middle school to introductory level college students.

Part 2 covers additional information on the earthquake history in the San Francisco Bay Area, examples of fault creep seen at the surface, how fault creep and locked patches occur together, earthquake probability, expected intensity of shaking, earthquake hazards, and practical ideas for preparedness. The tape is appropriate for high school and college-level students.

SUGGESTIONS FOR THE CLASSROOM

Earthquakes are an excellent medium for teaching a variety of topics from physics, to social studies. Most students find earthquakes exciting, and earthquakes get and hold their attention. Segments of *The Hayward Fault - We Can't Ignore It, videotapes Part 1 and Part 2,* complement most of the lessons from the *Tremor Troops - Earthquakes: A Teacher's Package for K-6, Seismic Sleuths - Earthquakes: A Teacher's Package for grades 7 - 12,* and other earth science textbooks.

The Hayward Fault - We Can't Ignore It, videotapes Part 1 and Part 2, can be used in a variety of ways in teaching about earthquakes, faults, and the impacts on society when a damaging earthquake occurs in a populated area. The videotape summarizes, in non-technical language, basic earthquake principles as well as the latest research on an active and potentially dangerous fault which crosses through a heavily populated urban area. Each part of the videotape can be shown from start to finish during separate class periods. Alternatively, individual sections can be viewed while stopping the videotape after each segment to discuss the principles illustrated, before proceeding on to the next segment. Another option is to select individual sections of the tape from the outline and present the topics in a different order, picking and choosing topics which correspond with your own teaching plan. Each section builds on the previous sections but does not require viewing the previous parts of the tape. It is not advisable simply to view the entire video tape (parts 1 and 2) for an hour without stopping: the information is too concentrated for a single viewing.

Several topics, not covered in most earthquake-related videotapes, are included in *The Hayward Fault - We Can't Ignore It.* These topics include , fault- related landforms, fault creep, the fault plane at depth, relationship between creep and fault rupture, regional earthquake history and future earthquake probability. Students who are familiar with faults and landscape development can benefit from the illustration and discussion of fault-related landforms. These landforms are then pictured in the animated flyover of the fault.

Similarly, *The Hayward Fault - We Can't Ignore It* does not repeat the discussion of plate tectonics, the "ring of fire" around the Pacific Ocean, and earthquakes around the world that is found in nearly every other earthquake video. This tape focuses on the features and science of a particularly dangerous

fault and is thus complementary to other earthquake videos.

Many basic earth science texts have students work with some kind of stick-slip fault model to show what happens when a fault ruptures and how elastic energy is stored in the rocks along the fault plane. In addition to producing large magnitude earthquakes the Hayward fault is one of the few faults in the world which clearly displays fault creep along its length. A simple experiment to illustrate the process of fault creep can be created with two boards and modeling clay. This process is pictured and discussed in the videotape. The relationship between the stick-slip fault rupture process and fault creep is described in the videotape. This relationship can be discussed with students, using the example of the Hayward fault which is locked at depth and creeping at the surface.

OUTLINE OF PART 1 (29 MINUTES)

Note: The distribution tape contains both parts 1 and 2. The timings are in minutes and seconds from the color bar screen at the very beginning of the videotape.

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   - 12:40 Fremont
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    29:07 End

OUTLINE OF PART 2 (33 MINUTES)

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3) 33:26 Earthquake probability
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12) 59:20 Conclusion to tape 2

    1:00:50 End

GLOSSARY

Dip-slip fault: Direction of movement of one side of the fault relative to the other side is up and down along the fault plane.

Earthquake: Shaking of the ground caused by the passage of seismic waves radiating outward through the earth from a fault that has suddenly ruptured and displacement has taken place.

En echelon shears: Diagonal series of fractures that develop in a pliable material such as asphalt or clay, produced by the horizontal movement of one side of the fault relative to the other side.

Faceted ridge: Relatively steep cut-face formed where fault movement has sliced off and removed a portion of the ridge.

Fault: A planar fracture in the earth's crust across which there has been relative movement or displacement.

Fault creep (tectonic creep): Slow surface fault movement, at the rate of a fraction of an inch a year, that does not generate earthquake waves.

Fault gouge: Ground-up and altered rock in the fault zone. Gouge acts as a dam-like barrier to water moving underground resulting in water coming to the surface along the fault as a line of springs or ponds.

Fault scarp: Relatively steep, straight slope that owes its relief to movement along a fault.

Ground shaking: Shaking that occurs when seismic or earthquake waves pass through the surface. This shaking causes the most destructive damage over the widest area.

Locked fault zone: Energy is stored in the rocks to be released in a large magnitude earthquake rather than frequently slipping and releasing it's stored elastic energy by generating more numerous, small earthquakes.

Linear ridge: An elongate ridge moved from its place of origin by faulting.

Linear valley: Valley formed by faulting, where fault shattered rock is carried away by erosion, creating a valley.

Liquefaction: A process where soils and other loose, unconsolidated materials containing abundant water are turned into a fluid-like mass when shaken by an earthquake. These materials are not then capable of supporting buildings, roads and other structures.

Intensity: Scale used to indicate the destructive effects of an earthquake. Intensity varies depending on the distance to the source, nature of subsurface materials, and the type and construction of the structure or building.

Magnitude: Scale used to measure of the size of the earthquake and the energy released. Determined from the seismogram record of the earthquake by taking the common logarithm (base 10) of the largest ground motion observed during the arrival of the seismic waves and applying a standard correction for distance to the source.

Right-lateral: Relative fault movement in which the side across the fault from the observer moves relatively to the right.

Stream offset: Streams displaced by strike-slip faulting make right angle bends at the fault. The bed of

a stream bed will moved when a strike-slip fault ruptures. The displaced stream flows parallel to the fault until it reconnects with its channel to continue flowing downhill. Offset streams indicate the direction of fault movement.

Strike-slip fault: Horizontal direction of movement of one side of the fault plane relative to the other side.

Surface rupture: Place on the earth's surface where the fault plane intersects and breaks the surface.

Water table: Surface below the ground where the rock and soil is saturated, and all open spaces are filled with water.

TECHNICAL REFERENCES

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Steinbrugge, K.V., Bennett, J.H., Lagorio, H.J., Davis, J.F., Borchardt, G. and Toppozada, T., 1987, Earthquake Planning Scenario for a Magnitude 7.5 Earthquake on the Hayward Fault in the San Francisco Bay Area: California Division of Mines and Geology, Special Publication 78, 245 p.

Taylor, C.L. and Cluff. J, 1982, Field Trip Guidebook for the Conference on Earthquake Hazards in the Eastern San Francisco Bay Area, March 24-27, 1982: California State University Hayward, 142 p.

Taylor, C.L., Hall, N.T., and Melody, M., 1992, Field Trip Guidebook for the Second Conference on Earthquake Hazards in the Eastern San Francisco Bay Area, March 25-29, 1992: California State University, Hayward, 225 p.

ADDITIONAL RESOURCES ON EARTHQUAKES AND PREPAREDNESS

American Geophysical Union and Federal Emergency Management Agency, 1994, *Seismic Sleuths - Earthquakes - A teachers package on earthquakes for grades 7-12,* 367pp., American Geophysical Union, 2000 Florida Ave. NW, Washington DC 20009.

American Red Cross, Los Angeles Chapter, 1985, *The Emergency Survival Handbook.*

Bolt, Bruce A., 1993, *Earthquakes.* New York: W.H. Freeman & Co., 331 pp.

Gere, J.M. and Shah, H. C., 1984, *Terra Non Firma: Understanding and Preparing for Earthquakes,* W,H. Freeman & Co., New York, 203 pp.

Federal Emergency Management Agency and National Science Teachers Association, 1988, *Tremor Troop - Earthquakes - A teacher's package for K-6,* 169 pp. plus master sheets, National Science Teachers Association, 1742 Connecticut Ave. NW, Washington DC 20009.

United States Geological Survey, Earth Science Information Center, 345 Middlefield Road, Menlo Park, CA 94025, (415) 329-4390, distributes numerous general interest and geologic pamphlets, fact sheets and maps, many of which are free.

COPYING POLICY

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3877 University Drive, Anchorage AK 99508
(800) 684-3368, (907) 563-7070, FAX: (907) 273-9192
email: penny_enders@kakm.pbs.org.
KAKM accepts credit card orders.
VHS tape cost is $9 plus $4 shipping.
Order weekdays from 9-5:30 Alaska time (10-6:30 Pacific time).

or

Instructional Media Center, Cal State Univ. Hayward, Hayward CA 94542.
Phone (510) 885-3692; Fax (510) 885-3953. $19.95 for VHS tape with color cover and 6-page report, including tax, shipping and handling.

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