U.S. DEPARTMENT OF THE INTERIOR
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GEOLOGIC MAP OF THE HAYWARD FAULT ZONE, CONTRA COSTA, ALAMEDA, AND SANTA CLARA COUNTIES, CALIFORNIA: A DIGITAL DATABASE

By

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This database, identified as "Geologic map of the Hayward fault zone, Contra Costa, Alameda, and Santa Clara Counties, California: A digital database," has been approved for release and publication by the Director of the USGS. Although this database has been subjected to rigorous review and is substantially complete, the USGS reserves the right to revise the data pursuant to further analysis and review. Furthermore, it is released on condition that neither the USGS nor the United States Government may be held liable for any damages resulting from its authorized or unauthorized use.

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Introduction

This digital map database, compiled from previously open-filed U.S. Geological Survey reports (Graymer and others, 1994, Graymer, Jones, and Brabb, 1994) and unpublished data, represents the general distribution of rocks and faults in the Hayward fault zone. As described in this report, the Hayward fault zone is a zone of highly deformed rocks which trends north 30 degrees west from an area southeast of San Jose to the San Pablo Bay, and ranges in width from 2 to 10 kilometers. Although historic earthquake activity has been concentrated in the western part of the zone, the zone as a whole reflects oblique right-lateral and compressive deformation along a significant upper crustal break over the past 10 million years or more. Together with the accompanying text file (hfgeo.txt), the database provides current information on the distribution and description of faults and rock types within the fault zone. In addition, the text file discusses the development of the fault zone in the past 10 million years, the relationship of the Hayward and Calaveras fault zones, and the significance of the creeping strand of the Hayward fault (as most recently defined by Lienkaemper, 1992). The scale of the source maps limits the resolution (scale) of the database to 1:50,000, except for Alameda County which has a resolution of 1:24,000. For those interested in the geology of the Hayward fault zone who do not use an ARC/INFO compatible Geographic Information System (GIS), three Postscript plot files containing images of much of the data in the digital database have been included. The content and character of the database, as well as two methods of obtaining the database, are described below.

Database Contents

The digital database consists of the geologic map database itself and the supporting data, including a fault map, base maps, map explanation, geologic description, and references. The geologic map database consists of three ARC coverages:

hfcc_um/	Geologic map of the Hayward fault zone in Contra Costra County
hfal_um/	Geologic map of the Hayward fault zone in Alameda County
hfsc_um/	Geologic map of the Hayward fault zone in Santa Clara County

The database directory also includes the following supporting directory, ARC coverages, and files:

Directory:

info/	INFO directory containing files supporting the databases

ARC Coverages:

hf_um-flt/	Map of faults in the Hayward fault zone with additional database items containing fault name (if any) and fault subzone (see hfgeo.txt for explanation of subzones).
hf_dr/	Drainage base map.
hf_cu/	Cultural base map.
hf_topo/	Topographic contours base map.

Files:

hfgeo.txt	A text only computer file containing detailed unit descriptions and geological information, plus sources of data and references cited.
hfdb.txt	This file.
hfkey.un hfkey.ln	Together, these key files produce a plottable or displayable map explaination and key.
hfnplt.ps	A Postscript plottable file containing an image of the geologic map of the northern half of the Hayward fault zone at a scale of 1:50,000 (Sheet 1).
hfsplt.ps	A Postscript plottable file containing an image of the geologic map of the southern half of the Hayward fault zone at a scale of 1:50,000 (Sheet 2).
hf-fplt.ps	A Postscript plottable file containing an image of the map of faults within the Hayward fault zone color coded to correspond to subzone at a scale of 1:100,000 (Sheet 3, see text file hfgeo.txt for explanation of subzones).

The database was compiled in ARC/INFO, a commercial Geographic Information System (Environmental Systems Research Institute, Redlands, California), and is stored in ARC coverage format (ARC/INFO version 7) in a UNIX tar file. A UNIX computer operating system is therefore required to extract the database from the tar file, and ARC/INFO is required for its use or conversion to other format. The digital compilation was done using version 7.0.2 of ARC/INFO with version 3.0 of the menu interface ALACARTE (Fitzgibbon and Wentworth, 1991, Fitzgibbon, 1991, Wentworth and Fitzgibbon, 1991).

Obtaining the Digital Data

A 18.6 MB compressed tar file of the database and related files can be obtained by anonymous ftp over Internet, or by sending a tape with request and return address to:

Hayward fault zone Database
c/o Carl M. Wentworth
U.S. Geological Survey
345 Middlefield Road, M/S 975
Menlo Park, CA 94025

Do not omit any part of this address!

The compressed tar file will be returned on the tape. The acceptable tape types are:
1/4 inch, 150 MB cartridge tape
2.3 or 5.0 GB, 8 mm Exabyte tape.

To obtain the tar file by ftp, log in to your UNIX system and do the following:

cd local_directory	-go to a directory to receive the tar file
ftp wrgis.wr.usgs.gov	-make ftp connection with the USGS computer WRGIS
Name: anonymous	-use "anonymous" as your user name
Password: your name	-use your own user name as password
cd pub/geologic	-go down to the pub/geologic directory
cd ca/of95-597	-go down to the open file directory
type binary	-change transfer type to binary
get hf_g1.tar.Z	-copy the compressed tar file across Internet to your directory
quit	-close the ftp connection

Extracting the Database from the Tar file

If you obtained the database on tape:

put the tape in your tape drive	
cd local_directory	-go to a directory to receive the tar file
tar xvfb /dev/rstn 20	-/dev/rstn is the tape device with n an integer, this puts the tar file in local_directory
uncompress hf_g1.tar.Z	-makes a 51 MB uncompressed tar file hf_g1.tar
cd local_directory2	-go to the directory that will hold the workspace hfg (if different from local_directory)
tar xvfb {path to tar file}/hf_g1.tar 20	-extract the hfg workspace from the tar file.

If you obtained the database by anonymous ftp:

uncompress hf_g1.tar.Z	-makes a 51 MB uncompressed tar file hf_g1.tar
cd local_directory2	-go to the directory that will hold the workspace hfg (if different from local_directory)
tar xvfb {path to tar file}/hf_g1.tar 20	-extract the hfg workspace from the tar file.

This process will create a workspace "/hfg" (a directory containing an INFO directory) that contains the databases and supporting files as described above.

Web Pages

The U.S. Geological Survey now supports a set of graphical pages on the World Wide Web. Digital publications (including this one) can be accessed via these pages. The location of the main web page for the entire U.S. Geological Survey is

"http://www.usgs.gov". The web page for digital publications from the Western Region (including this one) is "http://wrgis.wr.usgs.gov".

Digital Compilation

The geologic map information was digitized from stable originals of the geologic maps at 1:24,000 scale for Alameda County and 1:62,500 scale for Santa Clara and Contra Costa County. The author manuscripts (ink on mylar) were scanned using a Tektronix 4991 monochrome scanner with a resolution of 304.8 dots per inch. The scanned images were vectorized and transformed from scanner coordinates to projection coordinates with digital tics placed by hand at quadrangle corners. The scanned lines were edited interactively by hand using ALACARTE, color boundaries were tagged as a contact or fault as appropriate, and scanning artifacts visible at 1:24,000 (for Alameda County) or 1:50,000 (for Santa Clara or Contra Costa Counties) were removed.

Base Maps

Base Map layers were prepared from scale-stable printing negatives of the U.S. Geological Survey Napa (1983 edition), San Francisco (1978 edition), Stockton (1989 edition), and San Jose (1978 edition) 1:100,000 topographic maps, which have a 50 meter contour interval. Scanned and vectorized images were transformed from scanner coordinates to projection coordinates with digital tics placed by hand at map corners. The images were then trimmed interactively by hand using ALACARTE to conform to the area of the geologic coverages, and the four portions were combined. Small mismatches at the boundaries caused by slight differences in the original scans remain in the three base map coverages. These base map layers are digital images but no information other than location is attached to the lines. The base maps are provided for reference only.

Faults and Landslides

This map is intended to be of general use to engineers and land-use planners. However, its small scale does not provide sufficient detail for site developement purposes. In addition, this map does not take the place of fault-rupture hazard zones designated by the California State Geologist (Hart, 1988). Similarly, the database cannot be used to identify or delineate most landslides in the region, because only some large landslides are shown. For a more complete depiction of landslide distribution, see Nilsen and others (1979).

Spatial Resolution

Uses of this digital geologic map should not violate the spatial resolution of the data. Although the digital form of the data removes the constraint imposed by the scale of a paper map, the detail and accuracy inherent in map scale are also present in the digital data. The fact that this database was edited at a scale of 1:24,000 (for Alameda County) or 1:50,000 (for Contra Costa and Santa Clara Counties) means that higher resolution information is not present in the dataset. Plotting at scales larger than 1:24,000 (for Alameda County) or 1:50,000 will not yield greater real detail, although it may reveal fine-scale irregularities below the intended resolution of the database. Similarly, where this database is used in combination with other data of higher resolution, the resolution of the combined output will be limited by the lower resolution of these data. Note that in contrast to the geologic coverages, the base map layers have a resolution of 1:100,000, so significant discrepancies with the geologic coverages are possible. The base map layers are provided for reference only.

Postscript Plot Files

The database is in ARC coverage format, and therefore requires use of ARC/INFO or another compatible GIS system to access the information contained within it. For those interested in the geology of the Hayward fault zone, but who don't use an ARC/INFO compatible GIS system, we have included three Postscript plot files. One contains a plot of the northern half of the map database at 1:50,000 scale, along with a map explanation (Sheet 1, hfnplt.ps). The second contains a plot of the southern half of the map database at 1:50,000 scale, along with a diagram of quadrangles traversed by the fault zone (Sheet 2, hfsplt.ps). The third contains a plot of the fault information map (explained below) at 1:100,000 scale (Sheet 3, hf-fplt.ps). Because this release is primarily a digital database, the plot files (and plots derived therefrom) have not been edited to conform to U.S. Geological Survey standards. Small units have not been labeled with leaders and in some instances map features or annotation overlap. Sample plots by the authors have proven to be quite legible and useful, however.

Fault Information Map (hf_um-flt)

This coverage contains additional information about the faults in the Hayward fault zone. The subzone that the fault is in is recorded in the database item "DOMAIN." The fault name, if any, is recorded in the database item "FNAME." See below for more information about database items. Subzones are fully described in the accompanying text file, hfgeo.txt. This coverage contains fault lines (arcs) from all three counties, but no contact lines (arcs) or polygon information. This coverage is intended to illustrate concepts discussed in the geologic explanation (hfgeo.txt).

Database Specifics

The map databases consist of ARC coverages and supporting INFO files, which are stored in a UTM (Universal Transverse Mercator) projection (Table 1). Digital tics define a 7.5 minute grid of latitude and longitude in the geologic coverages corresponding with quadrangle corners. In the base map layers, the tics define a 7.5 minute grid, corresponding with quadrangle corners.

Table 1 - Map Projection

The map is stored in UTM projection

PROJECTION UTM	-Universal Transverse Mercator
UNITS METERS	-on the ground
ZONE 10	-UTM zone
PARAMETERS	
END	

The content of the geologic database can be described in terms of the lines and the areas that compose the map. Descriptions of the database fields use the terms explained in Table 2.

Table 2 - Field Definition Terms

ITEM NAME	name of the database field (item)
WIDTH	maximum number of digits or characters stored
OUTPUT	output width
TYPE	B-binary integer, F-binary floating point number,

I-ASCII integer, C-ASCII character string
N. DEC. number of decimal places maintained for floating point numbers

Lines -

The lines (arcs) are recorded as strings of vectors and are described in the arc attribute table (Table 3). They define the boundaries of the map units, faults that do not bound units, the boundaries of open bodies of water, and the map boundaries. These distinctions, including the geologic identities of the unit boundaries, are recorded in the LTYPE field according to the line types listed in Table 4. In addition, the coverage hf_um-flt contains two extra database items in the arc attribute table containing additional information related to faults within the Hayward fault zone.

Table 3 - Content of the Arc Attribute Tables

ITEM NAME	WIDTH	OUTPUT	TYPE	N. DEC	
FNODE#	4	5	B		starting node of arc (from node) TNODE#
4	5	B			ending node of arc (to node)
LPOLY#	4	5	B		polygon to the left of the arc
RPOLY#	4	5	B		polygon to the right of the arc
LENGTH	4	12	F	3	length of arc in meters
<coverage>#	4	5	B		unique internal control number
<coverage>-ID	4	5	B		unique identification number
LTYPE	35	35	C		line type (see Table 4)
DOMAIN	35	35	C		structural subzone (hf_um-flt only)
FNAME	35	35	C		fault name (hf_um-flt only)

Table 4 - Line Types Recorded in the LTYPE Field

atten. fault, certain (hf_um-flt only)
atten. fault, approx. located (hf_um-flt only)
contact, certain
contact, approx. located
contact, inferred
fault, certain
fault, approx. located
fault, concealed
fault, concealed, queried
fault, inferred
fault, inferred, queried
s.s. fault, r.l., approx. located
s.s. fault, r.l., certain
thrust fault, approx. located
thrust fault, certain
thrust fault, concealed
scratch boundary
water boundary
map boundary

The geologic linetypes are ALACARTE line types that correlate with the geologic line symbols in the ALACARTE line set GEOL61.LIN according to the ALACARTE lines lookup table (GEOL61.LUT). Note that fault and s.s. fault, r.l. are assigned the same symbol in the lookup table.

Areas -

Map units (polygons) are described in the polygon attribute table (Table 5) The identities of the map units from compilation sources are recorded in the PTYPE field by map label (Table 6). Map units are described more fully in the accompanying text file hfgeo.txt.

Table 5 - Content of the Polygon Attribute Tables

ITEM NAME	WIDTH	OUTPUT	TYPE	N. DEC	
AREA	4	12	F	3	area of polygon in square meters
PERIMETER	4	12	F	3	length of perimeter in meters
<coverage>#	4	5	B		unique internal control number
<coverage>-ID	4	5	B		unique identification number
PTYPE	35	35	C		unit label

Table 6 - Map Units

(See hfgeo.txt for descriptions of units)

.
JKf
JKfgm
JKfm
JKfn
JKk
Jkkc
JKkv
Jgb
Jpb
Jbp?
Jsv
Kc
Kcv
Kjm
Knc
Ko
Ko?
Kp
Kr
Ksc
Ksh
Kslt
Ku
QTi
QTi?
QTl
QTp
QTs
Qls
Qm
Qoa
Qu
Ta
Tbp
Tbr
Tcc
Tccs
Tccs?
Tes
Tgs
Tgss
Tm
Tms
Tn
To
To?
Tor
Torv
Tps
Ts
Tsh
Tsk
Tss
Tst
Tt
Ttls
Tts
Tus
Tush
Tv
fc
fg
fm
fs
sc
sp
sp?

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