DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GENERAL DISTRIBUTION OF GEOLOGIC MATERIALS IN THE SAN FRANCISCO BAY REGION, CALIFORNIA: A DIGITAL MAP DATABASE

compiled by

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based on the work of

E.E. Brabb (1989), S.E. Ellen and C.M. Wentworth (1995),
and E.J. Helley and K.R. Lajoie (1979)

Open-File Report 97-744

1997

INTRODUCTION

This digital map database, which is compiled from 1970's sources, describes the general distribution and identity of geologic materials in the San Francisco Bay region, California (figure 1). Although based on the units distinguished on geologic maps, it is not itself a geologic map because it does not address geologic structure or the stratigraphic organization of the map units in a systematic way. Instead, it is directed at the distribution and physical character of the geologic materials, following the pattern of its progenitors, Wentworth and others (1985) and Ellen and Wentworth (1995). Consultation of these reports and the other compilation sources will aid in using the database. This report corrects some errors from and replaces the earlier digital map database represented by Open-File Report 93-693, which covered only the area of sheet 3 southwest of the Calaveras fault.

The materials database delineates map units that differ in physical properties, although the differences between many of the units may be small, depending on the properties of interest for any particular application. The materials units are categorized in the database by general age and lithology, by the geologic units that they represent, and by the map labels used in the compilation sources, which permit direct correlation with the unit descriptions of those sources. For all but the most general uses, the map

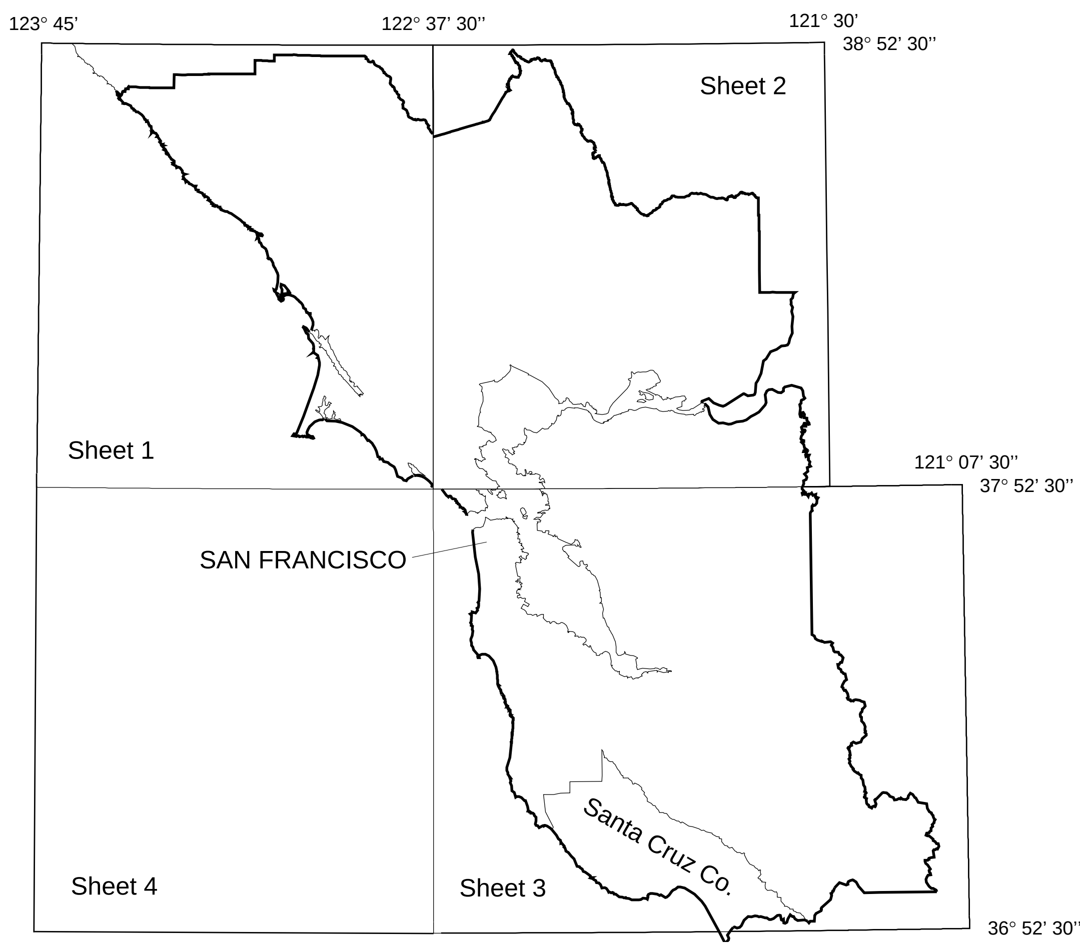

Figure 1. Map showing the 10-county area covered by the database (within heavy boundary), the area of Santa Cruz County, and the three sheets (1-3) into which the topographic base (Aitken, 1997) is divided. The materials database combines the three separate sheets in which it was originally compiled plus the southwest quadrant, but retains the internal sheet boundaries.

units will need to be assigned additional attributes, either from the unit descriptions in the compilation sources or by other means of characterization. The map scales of the sources limit the spatial resolution (scale) of the materials database to 1:125,000 or smaller. The database is thus useful for regional considerations that involve geologic materials, but does not replace the more detailed and up-to-date information required for evaluation of local areas.

The materials database was compiled over a period of several years with versions 4 through 7.0.4 of ARC/INFO, a commercial Geographic Information System (Environmental Systems Research Institute [ESRI], Redlands, California) on a UNIX computer using the menu interface ALACARTE (versions 1 through 3.1: Fitzgibbon and Wentworth, 1991; Fitzgibbon, 1991; Wentworth and Fitzgibbon, 1991).

The report consists of two spatial databases, each of which covers the whole region (the materials database and a database of 7.5-minute quadrangles), a map (as a digital map image) entitled "Geologic Materials of the San Francisco Bay Region", and supporting files. The map, at a scale of 1:275,000, was prepared from the materials database and combines the 377 materials units into 45 categories based on general age and lithology; it is only one of many maps that can be prepared from the database.

The report is stored as several digital files, including for the spatial data both ARC export (uncompressed) and ARCVIEW shape formats and for the map image both Postscript and PDF formats. The exported ARC coverages are in UTM zone 10 projection and the shape versions are in decimal degrees. This pamphlet, which simply describes the content and character of the digital map database, is included as both postscript and ASCII text files and is also available on paper as USGS Open-File Report 97-744. A plotted copy of the map can be ordered from a USGS Earth Science Information Center or by phone at 1-800-USMAPS (this service should become available sometime in 1999). Any or all of the digital files can be obtained over the Internet or by magnetic tape copy, as described below.

The full versatility of the spatial database is obtained by importing the ARC export files into ARC/INFO or an equivalent GIS package. Other GIS packages, including MapInfo and ARCVIEW, can use either the ARC export or shape files. The Postscript map image can be used for viewing or plotting in systems with sufficient capacity, and the considerably smaller PDF image file can be viewed or plotted in full or in part from Adobe ACROBAT running on Mac, PC, or UNIX platforms.

A digital version of the topographic base on which the materials map was compiled (U.S. Geological Survey, 1970), consisting of five vector layers (index contours, intermediate contours, drainage, culture, and detailed roads) for each of the three sheets (figure 1), is separately available as ARC export files in UTM zone 10 projection (Aitken, 1997).

OBTAINING THE DIGITAL DATA

The database and image files can be downloaded from the Western Region Geologic Information Server Web page or by anonymous ftp over the Internet, or can be obtained by submitting a tape on which requested files will be copied and returned.

Some of the files are assembled as tar files, and the larger files containing the databases and images have been compressed with gzip. Thus gzip is required to uncompress the files, and a tar utility is required to open the tar files.

The necessary utilities are available on-line:

gzip - This utility is available free of charge over the Internet from the gzip Home Page

http://w3.teaser.fr/~jlgailly/gzip

tar - This utility is included in most UNIX systems. Tar utilities for PC and Macintosh can be obtained free of charge via the Internet from Internet Literacy's Common Internet File Formats Web Page:

http://www.matisse.net/files/formats.html

Winzip - This commercial package runs on PCs and can deal with both gzip and tar files. An evaluation copy of WinZip for Windows 3.1, 95 and NT can be downloaded from:

http://www.winzip.com/winzip/:

DATABASE CONTENTS

The report consists of digital files representing the five parts of the database, some of which are presented in more than one format. The names of the files are unique designators based on the report identifier, of97-744, followed by part numbers and an extension indicating file type. Some of the files have been bundled in tar files (.tar extension) and the ARC/INFO files and shape files have been separately packaged in tar files that have been compressed with gzip, yielding a final .gz extension (see Presentation, below). The files and their identities are as follows:

1. Revision List: A list of the parts of the report and at what version number of the report each was last revised (if at all) followed by a chronologic list that describes any revisions (see REVISIONS, below).
   a. of97-744revs_a.txt ASCII file

2. Open File Text: The text of the open-file pamphlet (this text), which describes the database and how to obtain it. The ASCII version does not contain the index map (figure 1).
   a. of97-744_2a.txt ASCII file, 0.07 MB.
   b. of97-744_2b.ps Postscript file, 0.33 MB
   c. of97-744_2c.pdf PDF file, 0.07 MB

3. Materials Database: The data files representing the lines and polygons of the materials map and a supplementary file listing the map units (ARC export and ARCVIEW shape formats); some supporting files for use in ARC/INFO are also included.
   a. of97-744_3a.e00 -- ARC export coverage containing both lines and polygons (39.5 MB). Import.aml will name this coverage sf-mtls.

b. of97-744_3b.e00 -- ARC export INFO table that lists the geologic units in each materials unit (0.02 MB). Import.aml will name this table UNITS.

c. of97-744_3c.tar -- Supporting files for ARC/INFO use, bundled as one tar file (0.01 MB). When opened, the tar file yields:

- UNIT.REL, an INFO relate file that relates polygons in the materials map to the units table.
- utm2lam.prj and lam2utm.prj: projection files to convert between the UTM zone 10 projection of the database and the native Lambert projection of the topographic base on which the materials map and its sources were compiled.
- import.aml: an ASCII script written in Arc Macro Language that can be used to convert the ARC export files into usable coverages and INFO files that are assigned standard names (see IMPORTING THE ARC EXPORT FILES).

d. of97-744_3d.tar -- Line and polygon ARCVIEW shape files bundled as one tar file (45.5 MB). When opened, the tar file yields:

- line files mtllns.dbf, mtllns.shp, and mtllns.shx
- polygon files mtlpys.dbf, mtlpys.shp, and mtlpys.shx

e. of97-744_3e.dbf -- DBase table that lists the geologic units in each materials unit (0.05 MB).

4. Quadrangle Index Database: The data files representing the lines and polygons of the quadrangle index (ARC export and ARCVIEW shape format). The ARC version also includes quadrangle names as annotation.

a. of97-744_4a.e00 -- ARC export coverage containing lines, polygons, and annotation (1.1 MB). Import.aml will name this coverage sf-qdgrid.

b. of97-744_4b.tar -- Line and polygon ARCVIEW shape files bundled as one tar file (1 MB). When opened, the tar file yields:

- line files grdlns.dbf, grdlns.shp, and grdlns.shx
- polygon files grdpys.dbf, grdpys.shp, and grdpys.shx

5. Plot File for the Map: Geologic Materials of the San Francisco Bay Region, delineated in terms of lithology and geologic age -- map image measures 34 by 33 inches when plotted.

a. of97-744_5a.ps.gz Postscript file (27.7 MB compressed to 5.8 MB)

b. of97-744_5b.pdf PDF file (5.3 MB)

Presentation

Some of the database files are provided separately and some are packaged together in tar files.

Separate Files: The revision list (of97-744revs_a.txt) and the three versions of the Open-File text (of97-744_2a.txt, of97-744_2b.ps, of97-744_2c.pdf) are provided separately, together with an abbreviated version of the ASCII text version as a README.

of97-744-arcfiles.tar.gz: The ARC export coverages (of97-744_3a.e00, of97-744_4a.e00), Units INFO file (of97-744_3b.e00), and tar file containing projection files and import.aml (of97-744_3c.tar) are packaged together in a single gzip-compressed tar file. The 8.8 gz file unzips to a 40.7 MB tar file.

of97-744-shapefiles.tar.gz: The tar file of ARCVIEW shape files (of97-744_3d.tar, of97-744_4b.tar) and units database (of97-744_3e.dbf) are packaged together in a single gzip-compressed tar file. The 12.7 MB gz file unzips to a 46.4 MB tar file.

REVISIONS

Changes to any parts of the report (the numbered items described above and listed in the revision list of97-744revs_a.txt) may be made in the future if needed. These could involve, for example, fixing files that don't work, correcting geologic details, or adding new file formats or other components. Major revision of the basic geologic information would result in a new report.

The report begins at version 1.00. Any revisions will be noted in the revision list and will result in the recording of a new version number for the report. Small changes will be indicated by decimal increments and larger changes by integer increments in the version number. Revisions will be announced and maintained on the web page for this report on the Western Region Geologic Information Server (see next section).

OBTAINING THE DATA FILES

The simplest way to obtain the database is to download it over the World Wide Web from the USGS Western Region Geologic Information Server:

http://wrgis.wr.usgs.gov

From the main page, click on 'Geologic map databases' under the heading 'Data On-line'; next click on 'California'. Scroll down to the listing for this database (Open File Report 97-744) and click on the Open-File button, which takes you to the page for this publication. You can also go directly to that final page at:

http://wrgis.wr.usgs.gov/open-file/of97-744

On this page, the several parts of the report in their different file types are separately available. Set you web browser to save to a local disk and click on the appropriate links to download the desired files.

To download the files across the net via anonymous ftp:

ftp wrgis.wr.usgs.gov	- make ftp connection with the USGS computer wrgis.
Name: anonymous	- enter "anonymous" as your user name.
Password: [your address]	- enter your own email address as password.
cd pub/open-file	- go down to the pub/openfile directory on wrgis.
cd of97-744	- go down to the open file directory for this report on wrgis.
type binary	- change transfer type to binary.
ls	- list the available files, if necessary.

get [file name] - download each of the desired files separately with the ftp "get" command.

quit - close the ftp connection

To obtain files from the database on magnetic tape, send a tape with your request specifying the desired files and your return address to:

San Francisco Bay Geologic Materials Database
c/o Database Coordinator
U.S. Geological Survey
345 Middlefield Road MS 975
Menlo Park, CA 94025

The specified files bundled in a compressed tar file will be returned to you on the tape. The acceptable tape types are:

2.3 or 5.0 GB, 8 mm Exabyte tape

OPENING THE DATABASE FILES

For those database files that are provided in compressed form and/or are bundled in a tar file, preliminary processing is required before the files are accessible by your GIS or image applications.

Compressed Gzip Files

Files compressed with gzip (those with a .gz extension) can be uncompressed with gzip:

gzip -d [file name] - converts the compressed file name.gz to its uncompressed equivalent name. The compressed file is replaced by the uncompressed file.

Tar Files

To extract the contents of a tar file, first uncompress it with gzip if the extension is .tar.gz. Once the tar extension is exposed, extract the contents with tar:

tar xvf [name].tar - extract the contents from the tar file. The contained files will be written to the current directory; the source tar file will not be changed.

IMPORTING THE ARC EXPORT FILES

The ARC export files (__.e00) can be converted to ARC/INFO vector maps (coverages) and INFO files by running the import.aml that is included in the database. This will import the export files, assign standard names (see below), build the polygon coverages (if desired), and delete the export files once used (if desired). The ’build’ and ’delete’ options are enabled by answering YES to questions posed when the aml starts running. Rerunning the aml permits enabling those options previously denied, but will not interfere with the results of earlier runs. The aml checks for the presence of needed export files, for previously imported files, and for the need to build if that option is enabled. Run import.aml from the ARC prompt in the directory containing the export files:

ARC: &run import.aml - run import.aml, answer YES/NO to the questions posed in the dialog area to choose options to import the export files, keep or delete the export files, and build the imported polygon coverages.

Note that the arc coverages and separate INFO files will be given standard names:

of97-744_3a.e00	(Geologic Materials Database)	is named	sf-mtls
of97-744_3c.e00	(INFO units table)		UNITS
unit.rel.e00	(INFO relate file from of97-744_3e.tar)		UNIT.REL
of97-744_4a.e00	(Quadrangle Index Database)		sf-qdgrid

DIGITAL COMPILATION

The materials spatial database was compiled on a 1:125,000 topographic base (U.S. Geological Survey, 1970; Aitken, 1997) from three regional compilations of 1970's data. Two of the sources were photomechanically compiled in the 1970's on this same base and address the surficial deposits (flatland deposits: Helley and others, 1979) and the bedrock (hillside materials: Ellen and Wentworth, 1995) of the 9-county San Francisco Bay region. (The San Mateo County part of the hillside materials map is based, in turn, on Wentworth and others, 1985). The separate geologic map of Santa Cruz County (Brabb, 1989), also based largely on 1970's and older data, was compiled on the same base photo-enlarged to a scale of 1:62,500. For the present digital compilation, inked or scribed linework for each of these sources was scanned (400 or more dots per inch), converted from raster to vector form, imported into ARC/INFO, and hand edited and combined into a single coherent map.

Digital compilation began with preparation of digital versions of the sources. The original material used to digitize linework for the surficial deposits was author manuscript (ink on mylar) and for the hillside materials and Santa Cruz County geologic maps was digital print-publication files (prepared for color separation by scribing and scanning) together with scribed or drafted fault plates that were then separately scanned, edited, and vectorized. The faults and color boundaries were combined interactively by hand for each source separately using ALACARTE, with the color boundaries attributed as contacts or replaced by faults, as appropriate. The fault plate for Santa Cruz County required a slight xy shift and rotation in the computer to produce a reasonable fit with the color boundaries.

Combining the surficial and hillside maps involved much adjustment of common boundaries and, in many places, the creation of an intervening map unit (PTYPE[1] = 20) to occupy the space between the downslope margin of mapped bedrock and the upslope margin of mapped surficial deposits, as well as to represent unidentified islands within mapped surficial deposits. In the simplest case, a gap between surficial deposits and bedrock represents colluvium, but this new unit also includes areas of unmapped

1 See Database Specifics below for explanation of the database fields shown in capital letters.

Quaternary deposits, some quite large areas of possible bedrock with very subdued topography, and mapped colluvium in Santa Cruz County.

Scanning artifacts significant for display at a scale of 1:125,000 were corrected and some surficial boundaries were adjusted to better fit the base. The boundary of Santa Cruz County is included in the map to retain the integrity of units on either side and because of misfits across that boundary, which result from different sources and compilation objectives in the three compilation sources. Small adjustments were made to fit lines across the boundary, but larger misfits were retained. The detail of the Santa Cruz County geologic map has not been simplified to match the higher level of generalization of the surficial and hillside maps: a few geologic corrections have been made to lines and unit identities relative to the published map in consultation with E.E. Brabb.

The geologic identities of lines specified in the LTYPE field are largely those of the compilation sources, except that all contacts from the surficial map are coded as approximately located. Long reaches of concealed faults are not included.

The materials data were initially compiled as three separate sheets (sheets 1-3, fig. 1), and the outline of a fourth sheet was created to fill the southwest quadrant of the region (entirely water). When complete, these four sheets were combined into a single layer (coverage) and numerous small boundary misfits inherent in the source materials were adjusted; the internal boundaries of the original sheets were retained.

MATERIALS UNITS

The spatial database shows the distribution of 375 materials units, 17 surficial and 358 bedrock, as well as open water and the unmapped portions of the three compilation sheets. The primary unit identifier is an integer in the character field PTYPE (and its numeric equivalent NPTYPE), which ranges from -1 to 911. The numbering is not continuous because of the assignment of PTYPEs by categories according to the general character of the units (see Table 1).

The PTYPE organization of the materials units is based on the hillside map units of Ellen and Wentworth (1995) and of Wentworth and others (1985), which are organized by such physical properties as lithology, bedding, hardness, and fracture spacing. These categories range from subdivisions of mapped rock units to composites of several rock units (the latter particularly in San Mateo County). Here this scheme is extended to encompass all the units in the map area by (1) correlating the bedrock units in Santa Cruz County with hillside units to the northwest and east according to Brabb's unit descriptions, and (2) erecting new categories for the surficial units. Each PTYPE unit is relatively homogeneous in its range of physical properties (or at least in its degree or kinds of heterogeneity) and can be characterized by reference to the compilation sources or other observations. NPTYPEs less than 99 are surficial deposits and greater than 98 are bedrock units, including semiconsolidated Plio-Pleistocene deposits. The categorization of bedrock materials is described in the map explanations and Table 5 of Ellen and Wentworth (1995) and is summarized in Table 1 below.

Table 1. General PTYPE Categories

Descriptions of hillside materials categories are modified from Table 5 of Ellen and Wentworth (1995)

-1	- unmapped areas outside the 10-county region
0	- open water

1-19	- Holocene surficial deposits
20-70	- Pleistocene and undivided Quaternary surficial deposits
99 & 100’s	- soft sandstone, conglomerate, and clayey rock - largely Pliocene and Pleistocene deposits, including Santa Clara, Merced, and Tehama formations.
200’s	- volcanic rock - largely Sonoma Volcanics, Miocene basalts, tuffs, and Franciscan greenstone.
300-400’s	- firm sandstone and clayey rock - Tertiary sedimentary rocks, such as Briones and Neroly formations.
500’s	- siliceous rock - Mesozoic and Tertiary siliceous rocks, such as Franciscan chert and Claremont Shale.
600’s	- well-bedded, hard-firm sandstone and clayey rock - largely units of the Mesozoic Great Valley sequence.
700’s	- deformed hard sandstone and clayey rock - Franciscan sandstone.
801-804	- mixed clayey sheared rock and masses of fractured hard rock - Franciscan melange and variably sheared Franciscan metagreenstone.
805	- sheared serpentinite.
900’s	- hard homogeneous rock - granitic rock, diabase, and unsheared ultramafic rock.

PTYPE 20 is used to represent the unclaimed areas between surficial and hillside units that are too large to accommodate with a compromise common boundary, as well as most unmapped islands within mapped surficial deposits. PTYPE 21, in contrast, is used for (1) areas that are mapped as Quaternary deposits in the geologic sources for the hillside map but are not so shown on the surficial deposits map (Helley and others, 1979), (2) areas mapped as undivided Quaternary deposits (Qu) on the surficial deposits map, (3) some locally unidentified bedrock islands within mapped surficial deposits on sheet 3 and, south of Half Moon Bay and northwest of Santa Cruz County, and (4) the simplified surficial unit (UNIT = S) of Wentworth and others (1985) that is used here instead of the very intricate units of Helley and others (1979).

The NPTYPE field of the materials map database, values of which are numeric equivalents of the PTYPE character values, is included to permit database searches by ranges of NPTYPE. PTYPE is used as the principal unit identifier for compatibility with ALACARTE.

The physical properties of the map units are not described in detail in this report (see the unit descriptions in the compilation sources), but the units are categorized by general lithology (LITH) and age (AGE). Because the degree of consolidation or hardness of sedimentary geologic materials in the region typically increases with age, lithology and age together (AGELITH) provide a good first approximation of physical character. Note that some units do not easily fit into these categories, particularly because their age or lithology straddles the category boundaries.

The identities of the map units in the compilation sources are recorded in the UNIT database field by their map labels (numbers for the hillside materials map, conventional geologic labels for the surficial deposits and Santa Cruz County geologic maps). Only selected large landslides are included except in San Mateo County, where all the larger landslides and their bedrock identities are included (Wentworth and others, 1985). Geologic unit identities of the materials units reported in the compilation sources are recorded in the separate database table UNITS and in Appendix 1 as an aid in characterizing the units. A database relate named UNIT.REL is included to support queries in ARC/INFO about geologic units from within the spatial database to the UNITS table as a function of NPTYPE (unit.rel//geolunit).

FAULTS AND LANDSLIDES

Faults are distinguished in the database only as part of the physical character of the geologic materials and the database cannot be used to identify or delineate active faults in the region. Similarly, the database cannot be used to identify or delineate most landslides in the region. Larger landslides are included as part of the physical character of the materials in San Mateo County, but only those large landslides for which bedrock identity is uncertain are shown elsewhere in the region.

SPATIAL RESOLUTION

Uses of this digital map should not violate the spatial resolution of the data. Although the digital form of the data removes the physical 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 compiled from maps at a scale of 1:125,000 (1:62,500 in Santa Cruz County) means that higher resolution information is not present in the database. Use of the database at scales larger than 1:125,000 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 this data.

MAP OF AGE/LITHOLOGY CATEGORIES

A map image at a scale of 1:275,000, stored both as a postscript file (of97-744_5a.ps) and a PDF file (of97-744_5b.pdf), is included to show the general content of the materials database. It was assembled in UTm zone 10 projection, and includes the drainage base layer (Aitken, 1997). Map units are organized according to the 45 AGELITH categories of the materials units and geologic lines are symbolized as a function of the LTYPE values, using the ALACARTE lineset GEOLOGY.LIN and lookup table GEOLINE.LUT. Latitude-longitude tics at an interval of 7.5 minutes are included from the coverage sf-qdgrid by selecting and plotting arcs therein shorter than 550 m. This map is only one of many that can be prepared from the database, depending on how the units are characterized and aggregated. The scale of 1:275,000 (much smaller than the full resolution of the database) was selected to fit the map onto 36-inch-wide plotter paper.

SPECIFICS OF THE MATERIALS DATABASE

The materials spatial database itself consists of the data layer sf-mtls (ARC coverage), its supporting INFO files, and the INFO table named UNITS. The map layer is stored in UTM projection (zone 10) (see Table 2) and projection files are included to convert between that and the Lambert projection of the source maps. Digital tics define a 7.5 minute grid of latitude and longitude (and see 7.5 MINUTE QUADRANGLE GRID, below). The content of the map database can be described in terms of the lines and areas that compose it. Descriptions of the database fields use the terms of Table 3.

Table 2. Map Projection

projection	utm	(Universal Transverse Mercator)
units	meters	
zone	10	

Table 3. 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, N- ASCII 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 with characteristics that are described in the arc attribute table (see Table 4). They define the boundaries of the map units, the boundaries of open bodies of water, the map and internal sheet boundaries, scratch boundaries, and part of the boundary of Santa Cruz County. These distinctions, including the geologic identities of the unit boundaries, are recorded in the LTYPE database field according to the line types listed in Table 5. The compilation sources of the lines are recorded in the SOURCE field (see Table 6). Note that the lines that separate surficial and bedrock units outside Santa Cruz County, regardless of the specified source (1 or 2), have been modified to accommodate the gap between the two in the compilation sources, except where the gap was so large (typically greater than 80-100 m) that an area of PTYPE = 20 was defined.

Table 4. Content of the Arc Attribute Table (SF-MTLS.AAT)

ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	
FNODE#	4	5	B		starting node of arc (<u>from</u> node)
TNODE#	4	5	B	-	ending node of arc (<u>to</u> 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
SF-MTLS#	4	5	B	-	unique internal control number
SF-MTLS-ID	4	5	B	-	unique identification number
LTYPE	35	35	C	-	line type
SOURCE	2	2	I	-	compilation source of line

Table 5. Line Types Recorded in the LTYPE Field

The geologic line types (exclusive of the various boundaries) are ALACARTE line types that correlate with geologic line symbols in the ALACARTE line set GEOLOGY.LIN according to the ALACARTE lines lookup table GEOLINE.LUT.

contact, certain	fault, inferred, queried
contact, approx. located	fault, concealed
contact, inferred	county boundary

contact, inferred, queried	scratch boundary
contact, concealed	water boundary
fault, certain	sheet boundary
fault, approx. located	map boundary

Table 6. Sources of the Lines

The compilation sources of the lines are recorded in the SOURCE field by numeric codes that indicate the following sources:

CODE	SOURCE
1	Helley and others, 1979
2	Ellen and Wentworth, 1995
3	Brabb, 1989
4	water boundaries extracted from the vectorized base scan (Aitken, 1997)
5	county boundaries extracted from the vectorized base scan (Aitken, 1997)

Areas - The materials map units are recorded as vector polygons with characteristics that are described in the polygon attribute table (see Table 7). The primary unit identifier is PTYPE (and its numeric equivalent, NPTYPE). The UNIT database field contains the map labels used in the compilation sources, and the AGE, LITH, and AGELITH fields contain the general age and lithology categories to which the materials units are assigned. Landslides are indicated by a value of LS in the LSLIDE and UNIT fields and, outside of San Mateo County, by PTYPE and NPTYPE = 70 and a LITH value of ld. Within San Mateo County, the landslides are assigned PTYPE, AGE, and LITH values according to the bedrock unit of which they are composed (after the usage of Wentworth and others, 1985), and their identity as landslides is indicated by a value of LS in the LSLIDE field. Those polygons located within Santa Cruz County are indicated by a COUNTY value of 1 (otherwise 0).

Table 7. Content of the Polygon Attribute Table (SF-MTLS.PAT)

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
SF-MTLS#	4	5	B	-	unique internal control number
SF-MTLS-ID	4	5	B	-	unique identification number
PTYPE	35	35	C	-	materials category
NPTYPE	4	4	I	-	numeric PTYPE
LSLIDE	35	35	C	-	landslide = LS
UNIT	35	35	C	-	unit label from compilation source
COUNTY	1	1	I	-	= 1 in Santa Cruz Co., otherwise 0
AGE	3	3	C	-	age category
LITH	3	3	C	-	lithology category
AGELITH	7	7	C	-	combinations of AGE and LITH

Some special cases should be noted:

Some Tertiary materials units consisting of more than one age of geologic unit are subdivided by assigning different AGE values (Tu and Tl) to different polygons of the unit (see Appendix 1).

Some very small island polygons in sheet 3 within mapped surficial deposits that have no mapped identities are assigned a UNIT value of br (possible bedrock), but are included in PTYPE = 20, undifferentiated and unmapped Quaternary deposits.

Two of the many dams in the region are mapped and assigned UNIT = dam, but the remaining materials attributes are those of the underlying (surrounding) bedrock materials unit.

UNIT hcg in Santa Cruz County, which is gabbro, is assigned LITH = gr and is included in PTYPE = 907.

Table 8. Age Categories

CODE	AGE
h	Holocene
p	Pleistocene
Q	Quaternary undivided
QT	Pliocene and/or Quaternary
Tu	upper Tertiary
Tl	lower Tertiary
Mz	Mesozoic

Table 9. Lithology Categories

CODE	LITHOLOGY
ab	agglomerate, breccia
bv	mafic volcanic rocks
cs	clay, silt, sand, gravel
dm	diatomite, diatomaceous shale, some sandstone
fv	felsic volcanic rocks
gr	granitic rock
hg	high-grade metamorphic rocks
ld	landslide
ls	limestone
m	mud and silt
md	mudstone and shale, some sandstone
mm	sheared sandstone and shale (melange)
ms	low-grade metasandstone and shale
mv	low-grade metavolcanic rocks (greenstone)
s	sand, gravel, silt, and mud
sc	silica-carbonate rock
sch	schist
sl	porcelaneous or siliceous mudstone and shale; chert
sm	sandstone and mudstone or shale
sp	serpentinite

ss	sandstone and conglomerate, some mudstone or shale
tf	tuff, tuffaceous sandstone, some sandstone, volcanic rock
wm	soft, water-saturated mud, some silt
wt	welded tuff

Table 10. Age and Lithology Combinations

CODE	AGE	LITHOLOGY
	Holocene	
h-wm		soft, water-saturated mud, some silt
h-m		mud and silt
h-s		sand, gravel, silt, and mud
	Pleistocene	
p-s		sand and gravel
p-md		mudstone and shale, some sandstone
p-ss		sandstone, some mudstone
	QUATERNARY	
Q-cs		clay, silt, sand, gravel
Q-s		sand, gravel, silt, and mud
Q-ld		landslide
Q-ab		agglomerate, breccia
	PLIOCENE and/or QUATERNARY	
QT-md		mudstone, some sandstone
QT-sm		sandstone and mudstone
QT-ss		sandstone, some mudstone
QT-tf		tuff, tuffaceous sandstone, some sandstone, volcanic rock
QT-fv		felsic volcanic rocks
QT-bv		mafic volcanic rocks
	UPPER TERTIARY	
Tu-md		mudstone and shale, some sandstone
Tu-sl		porcelaneous and siliceous mudstone and shale
Tu-sm		sandstone and mudstone or shale
Tu-ss		sandstone, some mudstone or shale
Tu-ls		limestone
Tu-dm		diatomite, diatomaceous shale, some sandstone
Tu-tf		tuff, tuffaceous sandstone, some sandstone, volcanic rock
Tu-wt		welded tuff
Tu-ab		agglomerate, breccia
Tu-fv		felsic volcanic rocks
Tu-bv		mafic volcanic rocks
Tu-sc		silica-carbonate rock

LOWER TERTIARY	
Tl-md	mudstone and shale, some sandstone
Tl-sm	sandstone and mudstone or shale
Tl-ss	sandstone, some mudstone or shale
Tl-tf	tuff, tuffaceous sandstone, some sandstone, volcanic rock
Tl-fv	felsic volcanic rocks

MESOZOIC	
Mz-md	mudstone and shale
Mz-sm	sandstone and shale
Mz-ss	sandstone and conglomerate, some shale
Mz-mm	sheared sandstone and shale (melange)
Mz-ms	metasandstone, some shale
Mz-mv	metavolcanic rocks (greenstone)
Mz-sl	chert
Mz-ls	limestone
Mz-bv	mafic volcanic rocks
Mz-fv	felsic volcanic rocks
Mz-sp	serpentinite
Mz-sch	schist and marble
Mz-gr	granitic rock
Mz-hg	high-grade metamorphic rocks

Geologic Units - The geologic units included in each of the materials units are listed in Appendix 1 and in the INFO table UNITS. This table contains the database field GEOLUNIT, in which the geologic units are listed (see Table 11), and a relating field NPTYPE. These geologic units range from rock types to formal stratigraphic names, as shown in the compilation sources. The UNITS table can be used directly in ARC/INFO or by relating from polygons in the materials data layer by way of NPTYPE to GEOLUNIT values in the table using the relate UNIT.REL (unit.rel\\geolunit).

Table 11. Table of Geologic Units

ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	
NPTYPE	4	4	I	-	NPTYPE in the polygon attribute table
GEOLUNIT	125	125	C	-	geologic units included in the materials unit

Tics - The digital tics in the materials data layer sf-mtls define a regular grid of 7.5 minute latitude/longitude intersections. The four corner tics are numbered 1 through 4 clockwise starting at the southeast corner (see figure 1 for latitude/longitude values), with the rest numbered in sequence from left to right and top to bottom. Four tics near or at the outer corners of each individual sheet (figure 1) were used to register the base layers with the surficial deposits and hillside materials sources. Similarly, four tics near the outer corners of the Santa Cruz County geologic map were used to register that map with the materials compilation.

7.5-MINUTE QUADRANGLE GRID

A separate vector layer of the map area (sf-qdgrid) contains 7.5 minute quadrangle boundaries and names. The grid of 7.5-minute lines of latitude and longitude and the intervening polygons define the quadrangles, and the quadrangles are named both in the NAME field of the polygon database and as diagonal (quad-centered, level 2) and horizontal (upper left, level 3) annotation. The lines are split around the quadrangle corners such that selection of arcs with length less than 550 m yields 7.5 minute latitude/longitude graphic tics 1000 m in diameter. Line attributes permit further distinction. The LTYPE field distinguishes the 15 minute quadrangle boundaries (LTYPE = ’15’) from the intervening 7.5 quadrangle boundaries (LTYPE = ’7.5’). The southern and western sides of the odd-shaped Santa Cruz 7.5 quadrangle are included with LTYPE = ’santa cruz’. A separate TICS field similarly distinguishes the 15 minute graphic tics (TICS = ’15’) from the intervening 7.5 minute tics (TICS = ’7.5’). (Note that these latitude/longitude tics defined by lines are different than the standard digital tics of the database, which are also located at the 7.5 minute intersections.)

This quadrangle grid can be used to obtain latitude/longitude tics in plotting, for plotting of quadrangle boundaries and names, and for queries involving quadrangle identities. The quadrangle polygons can also be used to record information by quadrangle (after adding appropriate database fields).

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Appendix 1. Summary Descriptions of the Materials Units

Units are listed by PTYPE, with equivalent AGELITH values from the map PATs and GEOLUNIT values from the INFO table UNITS. For some units, multiple AGE or LITH values are listed, because of differences within the materials unit. See Ellen and Wentworth (1995) for cited references.

PTYPE:	AGELITH	Geologic Unit (GEOLUNIT)
-1:		unmapped area
0:		open water
1:	h-wm	Holocene Bay Mud (Qhbm)
2:	h-m	fine-grained Holocene alluvium (Qhaf)
3:	h-m	fine-grained salt-affected Holocene alluvium (Qhafs)
10:	h-s	Holocene beach and dune sand
11:	h-s	medium-grained Holocene alluvium (Qham)
12:	h-s	coarse-grained Holocene alluvium (Qhac)
13:	h-s	Holocene stream-channel deposits (Qhsc)
20:	Q-cs	undiv. and unmapped Quaternary deposits including colluvium between surficial deposits and hillside materials
21:	Q-s	undiv. mapped Quaternary deposits: alluvium terrace deposits Millerton Fm undivided Quaternary and some bedrock islands
30:	p-s	late Pleistocene alluvium (Qpa)
31:	p-s	Colma Fm (Qpmc)
32:	p-s	Merritt Sand (Qps)
33:	p-s	eolian deposits of Sunset Beach and of Manresa Beach and eolian lithofacies of Aromas Sand
35:	p-s	Pleistocene marine terrace deposits (Qpmt)
40:	p-s	Early Pleistocene alluvium (Qpea)
70:	Q-ld	landslide deposit
99:	QT-ss	undiv. nonmarine sand and silt
100:	QT-ss	gravel deposits
101:	QT-ss	Santa Clara Fm undiv.
102:	QT-ss	Corte Madera facies of Santa Clara Fm
103:	QT-ss	Arastradero facies of Santa Clara Fm
104:	QT-ss	Woodside facies of Santa Clara Fm
105:	QT-ss	Stevens Creek facies of Santa Clara Fm

106	QT-ss	Los Gatos facies of Santa Clara Fm
107:	QT-ss	Searsville facies of Santa Clara Fm
108:	Tu-ss	conglomerate member of Ohlson Ranch Fm of Higgins (1960)
110:	Q-ss	Montezuma Fm
111:	QT-ss	sedimentary rocks
112:	QT-ss	Merced Fm
113:	QT-ss	Merced Fm
114:	QT-ss	Merced Fm
115:	Tu-ss	Wilson Grove Fm
116:	Tu-ss	Ohlson Ranch Fm of Higgins (1960) undiv.
117:	Tu-ss	sandstone member of Ohlson ranch Fm of Higgins (1960)
118:	Tu-ss	Garrity unit of Wagner (1978)
120:	QT-sm	sedimentary rocks
121:	QT-sm	sedimentary rocks
122:	QT-ss	sedimentary rocks
123:	Tu-sm	Glenn Ellen and Huichica Fms and older fluvial deposits
124:	Tu-ss	Tehama Fm
125:	Tu-sm	Tehama Fm
126:	Tu-sm	Oro Loma Fm of Briggs (1953)
127:	Tu-sm	Purisima Fm and siltstone and sandstone equiv. to Purisima Fm (Allen 1946)
128:	Tu-ss	upper Mulholland Fm of Ham (1952)
129:	Tu-sm	lower Mulholland Fm of Ham (1952)
130:	Tu-sm	Contra Costa Group undiv.
131:	Tu-sm	Contra Costa Group undiv.
132:	Tu-sm	clastic member of Moraga Fm
133:	Tu-sm	Orinda Fm
134:	Tu-sm	Orinda Fm
140:	QT-tf	tuffaceous member of Glen Ellen Fm
141:	Tu-sm	sedimentary deposits
150:	p-md	Montezuma Fm
151:	QT-md	sedimentary rocks
152:	QT-md	sedimentary rocks
153:	QT-md	clayey facies of Glen Ellen and Huichica Fms
154:	Tu-md	Siesta Fm
155:	Tu-md	Petaluma Fm
156:	Tu-md	claystone member of Petaluma Fm
200:	Tu-bv	andesite and basalt
201:	Tu-bv	andesite
202:	Tu-fv	andesitic to dacitic Sonoma Volcanics
203:	Tu-fv	rhyodacite intrusions
204:	Tu-fv	rhyolitic Sonoma Volcanics
210:	Tu-bv	Putnam Peak Basalt
211:	QT-bv	basalt
212:	Tu-bv	olivine basalt member of Clear lake Volcanics
213:	Tu-bv	Bald Peak Basalt
214:	Tu-bv	basalt flows of Sonoma Volcanics
215:	Mx-fv	Leona Rhyolite
216:	Mz-fv	rhyolite including Alum Rock Rhyolite of Crittenden (1951)
217:	QT-fv	Clear lake Volcanics

218:	Tu-fv	rhyolitic flows of Sonoma Volcanics
219:	Tu-fv	perlitic rhyolite of Sonoma Volcanics
220:	Tu-fv	soda rhyolite flows of Sonoma Volcanics
221:	Mz-fv	Northbrae Rhyolite
230:	Tu-bv	basalt
231:	Tu-bv	Page Mill Basalt
232:	Mz,Tu-bv	Page Mill Basalt Mindego Basalt diabase and other volcanic rocks
233:	Tu-bv	basalt and andesite member of Moraga Fm
234:	Tu-bv	andesitic to basaltic flows of Sonoma Volcanics
235:	Tu-fv	andesitic and basaltic flows of Sonoma Volcanics
236:	Tu-fv	Sonoma Volcanics
237:	Tu-fv	andesitic to basaltic flows of Sonoma Volcanics and sedimentary rocks
238:	Tu-tf	ash-flow tuff of Sonoma Volcanics and andesitic to basaltic flows
239:	Mz-fv	volcanic rocks at Lone Hill
240:	Tu-fv	rhyolite flows of Sonoma Volcanics
241:	Tu-ab	rhyolitic breccia of Sonoma Volcanics
250:	Mz-bv	volcanic rocks
251:	Mz-bv	Spilite near Black Point
253:	Mz-mv	greenstone of Franciscan assemblage and quartz keratophyre
254:	Mz-mv	metagreenstone of Franciscan assemblage
255:	Mz-mv	basaltic pillow lava and breccia
256:	Mz-bv	basaltic pillow lava and breccia
260:	Tu-fv	volcanic rocks
261:	Tu-wt	welded tuff of Sonoma Volcanics
262:	Tu-wt	xenolithic welded tuff of Sonoma Volcanics
270:	Tu-tf	ash-flow tuff of Sonoma Volcanics
271:	Tu-tf	tuff member of Clear Lake Volcanics
272:	Tu-tf	lithic tuff of Sonoma Volcanics
273:	Tu-ab	agglomerate of Sonoma Volcanics
274:	Tu-bv	andesitic or basaltic agglomerate
275:	Q-ab	tuff and rhyolitic gravel
280:	QT-tf	Cache Fm
281:	Tu-fv	Lawlor Tuff
282:	Tu-fv	Pinole Tuff
283:	Tu-fv	tuff at base of Contra Costa Group
284:	Tu-fv	tuff member of Orinda Fm
285:	Tl-fv	tuff member of Kirker Fm of Primmer (1964)
290:	Tl-fv	Sonoma Volcanics
291:	Tu-fv	volcanic rocks equiv. to Quien Sabe Volcanics of Leith (1949)
300:	Mz-bv	fluvial and lacustrine deposits of Little Sulphur Creek
301:	Tu-ss	conglomerate in G member of Wagner (1978) of Briones Sandstone
302:	Tu-ss	basal conglomerate of Monterey Group
303:	Tl-ss	conglomerate at Point Reyes
310:	Tu-ss	San Gregorio Sandstone Member of Purisima Fm and Santa Margarita Sandstone
311:	Tu-ss	sandstone
312:	Tu-ss	sandstone
313:	Tu-ss	Laird Sandstone
314:	Tl-ss	middle sandstone unit of Nortonville Shale
315:	Tl-ss	upper sandstone member of unnamed formation

320:	Tu-ss	Cierbo Sandstone
321:	Tu-ss	Temblor(?) Sandstone
322:	Tu-ss	Temblor(?) Sandstone
323:	Tu,Tl-ss	Lompico Sandstone Butano Sandstone Zayante Sandstone and sandstone of Mt Madonna area
330:	Tu-ss	E member of Wagner (1978) of Briones Sandstone
331:	Tu-ss	D member of Wagner (1978) of Briones Sandstone
332:	Tu-ss	sandstone unit of Monterey Group
333:	Tu-ss	Oursan Sandstone
334:	Tu-ss	Sobrante Sandstone
335:	Tl-ss	tuffaceous sandstone member of Kirker Fm of Primmer (1964)
340:	Tu-ss	glauconitic sandstone unit
342:	Tu-ss	Temblor(?) Sandstone
343:	Tl-ss	upper sandstone member of Domengine Sandstone
344:	Tl-ss	upper part of Domengine Sandstone
345:	Tl-ss	divisions A and B of Clark and Woodford (1927) of Meganos Fm
350:	Tu-sm	San Pablo Group undiv.
351:	Tu-ss	San Pablo Group undiv.
352:	Tu-ss	Neroly Sandstone
353:	Tu-ss	Cierbo Sandstone
354:	Tu-sm	Cierbo Sandstone
355:	Tu-ss	Briones Sandstone
356:	Tu-ss	Briones Sandstone undiv. and upper part of Briones Sandstone
357:	Tu-ss	Briones Sandstone
358:	Tu-sm	Briones(?) Sandstone
359:	Tu-ss	Briones Sandstone
360:	Tu-ss	E member of Wagner (1978) of Briones Sandstone
361:	Tu-ss	lower part of Briones Sandstone
362:	Tu-ss	lower part of Briones Sandstone
363:	Tu-ss	unnamed sandstone and Purisima Fm
364:	Tu-ss	Hambre Sandstone of Monterey Group
365:	Tu-sm	sandstone and mudstone near Fort Ross
366:	Tu-ss	Temblor Sandstone
367:	Tu-ss	San Ramon Sandstone
368:	Tu-ss	Sobrante Sandstone of Monterey Group and San Ramon Sandstone
369:	Tl-ss	Vaqueros Sandstone Butano Sandstone and Locatelli Fm
370:	Tl-sm	Butano Sandstone
371:	Tl-ss	Markley(?) Fm
372:	Tl-ss	Markley Fm
373:	Tl-sm	lower sandstone member of Markley Fm and Markley Fm
374:	Tl-sm	shale and sandstone
375:	Tl-ss	Tolman Fm of Hall (1958)
376:	Tl-ss	Domengine Sandstone
377:	Tl-ss	division D of Clark and Woodford (1927) of Meganos Fm
378:	Tl-ss	strata of German Rancho
379:	Tl-ss	undiv. sandstone mudstone and conglomerate
380:	Tu-ss	Purisima Fm undiv. Tunitas Sandstone and Tahana Members of Purisima Fm and unnamed sandstone
381:	Tu-ss	Neroly Sandstone

382:	Tu-sm	G and I members of Wagner (1978) of Briones Sandstone
383:	Tu-sm	F member of Wagner (1978) of Briones Sandstone
384:	Tu-sm	sandstone siltstone and shale mapped as Monterey Shale by Weaver (1949)
385:	Tu-ss	sandstone unit of Monterey Group
386:	Tu-ss	Hambre Sandstone of Monterey Group
387:	Tu-ss	Hambre Sandstone of Monterey Group
388:	Tu-ss	Oursan Sandstone of Monterey Group
389:	Tu-ss	Oursan Sandstone of Monterey Group
390:	Tu-ss	sandstone member of Claremont Shale of Monterey Group
391:	Tu-sm	Sobrante Sandstone of Monterey Group
392:	Tu-ss	Sobrante Sandstone
393:	Tu-ss	Temblor(?) Sandstone
394:	Tl-ss	San Ramon Sandstone and sandstone member of Kirker Fm of Primmer (1964)
399:	Tu-sm	sandstone
400:	Tu-sm	Neroly Sandstone
401:	Tu-sm	Neroly Sandstone
402:	Tu-sm	Neroly Sandstone
403:	Tu-ss	Neroly Sandstone
404:	Tu-sm	Briones Sandstone
405:	Tu-sm	upper part of Briones Sandstone
406:	Tu-sm	sandstone unit of Monterey Group
407:	Tu-sm	unnamed unit
408:	Tu-sm	Sobrante(?) Sandstone of Monterey Group
409:	Tu-sm	San Ramon Sandstone
410:	Tl-ss	Markley Fm
411:	Tl-sm	Markley(?) Fm
412:	Tl-sm	upper sandstone member of Markley Fm
413:	Tl-sm	sandstone member of Nortonville Shale
414:	Tl-sm	Domengine Sandstone
415:	Tl-ss	Domengine Sandstone
416:	Tl-sm	Domengine Sandstone
417:	Tl-sm	Domengine Sandstone
418:	Tl-sm	divisions D and E of Clark and Woodford (1927) of Meganos Fm
419:	Tl-ss	sandstone unit in division C of Clark and Woodford (1927) of Meganos Fm
420:	Tl-sm	divisions A B and C of Clark and Woodford (1927) of Meganos Fm
421:	Tl-sm	Butano(?) Sandstone
422:	Tl-sm	Tesla Fm
423:	Tl-sm	sandstone
424:	Tl-sm	Martinez Fm
425:	Tl-ss	lower glauconitic sandstone member of Martinez Fm
426:	Tl-sm	lower glauconitic sandstone member of Martinez Fm
430:	Tu-sm	siltstone and mudstone unit
431:	Tu-ss	siltstone member of Neroly Sandstone
432:	Tu-sm	lower part of Briones Sandstone
433:	Tu-md	clay shale unit of Monterey Group
435:	Tl-md	Markley Fm
436:	Tl-md	Sidney siltstone unit probably equiv. to Sidney Flat Shale Member of Fulmer (1964) of Markley Fm
438:	Tl-md	Nortonville Shale

439:	Tl-sm	Nortonville Shale
440:	Tu-sm	Nortonville Shale
441:	Tl-sm	lower part of Domengine Sandstone equiv. to Muir Sandstone of Weaver (1953)
442:	Tl-md	lower siltstone and claystone member of Domengine Sandstone
443:	Tl-sm	lower siltstone and claystone member and white sandstone unit of Domengine Sandstone
444:	Tl-md	division E of Clark and Woodford (1927) of Meganos Fm
445:	Tl-md	division C of Clark and Woodford (1927) of Meganos Fm
446:	Tl-sm	sandstone unit in division C of Clark and Woodford (1927) of Meganos Fm
448:	Tl-md	unnamed formation
449:	Tl-md	Martinez Fm undiv.
450:	Tl-md	Martinez Fm
451:	Tl-md	upper siltstone and shale member of Martinez Fm
452:	Tl-ss	lower glauconitic sandstone member of Martinez Fm
453:	Tl-md	unnamed sedimentary unit
460:	Tu,Tl-md	Lobitos Mudstone Mbr of Purisima Fm Lambert Sh San Lorenzo Fm Rices Mudstone Mbr of San Lorenzo Fm and mdst of Mayamus Flat
461:	Tl-md	Twobar Sh Member of San Lorenzo Fm shale member of Butano Sandstone Locatelli Fm and unnamed shale
465:	Tl-md	Nortonville Shale
466:	Tl-md	upper shale unit of Nortonville Shale
467:	Tl-md	lower shale unit of Nortonville Shale
468:	Tl-md	division C of Clark and Woodford (1927) of Meganos Formation
469:	Tl-md	division C of Clark and Woodford (1927) of Meganos Fm
470:	Tl-md	Vacaville Shale of Merriam and Turner (1937)
471:	Tl-md	Capay Fm
472:	Tl-md	Capay Fm
473:	Tl-md	unnamed sedimentary unit
474:	Tl-md	upper siltstone and shale member of Martinez Fm
500:	Tu-sl	Pomponio Mudstone Member of Purisima Fm Monterey Group Santa Cruz Mudstone Lambert Shale and shale of Mt Pajaro area
501:	Tu-sl	Monterey Group
503:	Tu-sl	shale unit of Monterey Group
504:	Tu-sl	shale unit of Monterey Group
506:	Tu-sl	Claremont Shale of Monterey Group
507:	Tu-sl	Claremont Shale of Monterey Group
508:	Tu-sl	Claremont Shale of Monterey Group
509:	Tu-sl	shale and sandstone
510:	Tu-sl	Pinehurst Shale
511:	Mz-sl	chert and metachert of Franciscan assemblage
519:	Tu-dm	diatomite with interbedded sand gravel and tuff
520:	Tu-ls	limestone in E member of Wagner (1978) of Briones Sandstone
521:	Tu-md	Hercules Shale Member of Briones Sandstone
522:	Tu-sl	Monterey Group
523:	Tu-sl	Monterey Group
524:	Tu-sl	Monterey Group
525:	Tu-sl	Monterey Group
526:	Tu-sl	Monterey Group

527:	Tu-sm	Monterey Group undiv.
528:	Tu-sm	Monterey Group undiv.
529:	Tu-sl	Rodeo Shale of Monterey Group
530:	Tu-sl	Tice Shale of Monterey Group
532:	Tu-sl	Tice Shale of Monterey Group
533:	Tu-ss	Oursan Sandstone Claremont Shale and Sobrante Sandstone undiv. of Monterey Group
534:	Tu-sl	Claremont Shale of Monterey Group
535:	Tu-dm	diatomite unit of Monterey Group
536:	Tu-sl	Lambert Shale
537:	Tl-md	upper part of Sidney Flat Shale Member of Fulmer (1964) of Markley Fm
538:	Tl-md	lower part of Sidney Flat Shale Member of Fulmer (1964) of Markley Fm
539:	Tl-md	Markley Fm equiv. to Kellogg Shale of Clark and Campbell (1942)
540:	Tl-md	Markley Fm and Nortonville Shale undiv.
541:	Tl-sl	mudstone
600:	Mz-ss	conglomerate unit of Great Valley sequence
601:	Mz-ss	conglomerate unit of Great Valley sequence
602:	Mz-ss	conglomerate unit of Great Valley sequence
603:	Mz-ss	Novato Conglomerate
604:	Mz-ss	conglomerate unit of Great Valley sequence
610:	Mz-ss	conglomerate in unnamed unit
611:	Mz-ss	conglomerate unit of Great Valley sequence
612:	Mz-ss	conglomerate unit of Great Valley sequence that is part of Del Valle Fm of Hall (1958)
613:	Tl-sm	strata of Stewarts Point
614:	Mz-ss	conglomerate member of Redwood Canyon Fm
615:	Mz-ss	Oakland Conglomerate
616:	Mz-ss	conglomerate
620:	Mz-ss	mapped sandstone in unnamed unit
621:	Mz-ss	sandstone unit in unnamed sandstone and shale of Great Valley sequence
622:	Mz-sm	sandstone unit of Great Valley sequence
623:	Mz-sm	sandstone unit of Great Valley sequence
624:	Mz-sm	sandstone and shale unit of Great Valley sequence
625:	Mz-ss	sandstone unit of Great Valley sequence
626:	Mz-ss	sandstone unit of Great Valley sequence
627:	Mz-ss	sandstone unit of Great Valley sequence
628:	Mz-ss	Deer Valley Fm of Colburn (1964)
629:	Mz-sm	mappable sandstone in lower member of Moreno Fm
630:	Mz-ss	Redwood Canyon Fm
631:	Mz-ss	sandstone unit of Great Valley sequence equiv. F-2 zone of Goudkoff (1942)
632:	Mz-ss	Guinda Fm of Kirby (1942)
633:	Mz-ss	Sites Fm of Kirby (1942)
634:	Mz-ss	Venado Fm of Kirby (1943)
635:	Mz-sm	lower part of Knoxville Fm (Robinson 1965) and part of shale unit
640:	Tl-sm	unnamed sandstone shale and conglomerate
641:	Mz-sm	shale and sandstone in unnamed unit
642:	Tl-sm	shale and sandstone
643:	Mz-sm	unnamed unit of Great Valley sequence
644:	Mz-sm	sandstone and shale unit of Great Valley sequence

645:	Mz-sm	sandstone and shale unit of Great Valley sequence
646:	Mz-sm	sandstone shale and minor conglomerate unit of Great Valley sequence
647:	Mz-sm	sandstone and shale unit of Great Valley sequence and sandstone of Nibbs Knob area
648:	Mz-sm	unnamed formation of Great Valley sequence
649:	Mz-sm	sandstone unit of Great Valley sequence
650:	Mz-sm	Joaquin Ridge Sandstone Member of Goudkoff (1945) of Panoche Fm
651:	Mz-sm	Mappable sandstone interbeds in upper shale and siltstone member of Marlife Shale of Payne (1962)
652:	Mz-sm	middle sandstone member of Marlife Shale of Payne (1962)
653:	Mz-ss	sandstone unit of great Valley sequence equiv. G-1 zone of Goudkoff (1942)
654:	Mz-sm	Joaquin Miller Fm
655:	Mz-sm	unnamed sandstone and shale of Great Valley sequence
656:	Mz-sm,ss	Pigeon Point Fm and sandstone at San Bruno Mtn
657:	Mz-sm	unnamed formation of Great Valley sequence
658:	Mz-sm	Great Valley sequence undiv.
659:	Mz-sm	sandstone and claystone unit of Great Valley sequence
660:	Mz-md,sm	shale unit of Great Valley sequence
661:	Mz-md	shale unit of Great Valley sequence
662:	Mz-md	shale unit of Great Valley sequence
663:	Mz-md	shale unit of Great Valley sequence
664:	Mz-sm	sandstone shale and minor conglomerate unit of Great Valley sequence
665:	Mz-md	sandstone unit of Great Valley sequence
666:	Mz-sm	strata of Anchor Bay
667:	Mz-sm	Shephard Creek Fm
668:	Mz-md	shale units of Great Valley sequence probably equiv. to E and F-2 zones of Goudkoff (1942)
669:	Mz-md	Forbes Fm of Kirby (1942)
670:	Mz-md	Funks Fm of Kirby (1942)
671:	Mz-md	Yolo Fm of Kirby (1942)
672:	Mz-md	upper siltstone member of Moreno Fm
673:	Mz-md	lower shale and claystone member of Moreno Fm
674:	Mz-md	shale interbeds in Joaquin Ridge Sandstone Member of Goudkoff (1945) of Panoche Fm
675:	Mz-md	upper shale and siltstone member of Marlife Shale of Payne (1962)
676:	Mz-sm	lower shale and siltstone member of Marlife Shale of Payne (1962)
677:	Mz-md	mappable sandstone interbeds in lower shale and siltstone member of Marlife Shale of Payne
678:	Mz-sm	unnamed sandstone and shale of Great Valley sequence
679:	Mz-md	shale unit in unnamed sandstone and shale of Great Valley sequence
680:	Mz-sm	unnamed shale of Great Valley sequence
681:	Mz-md	unnamed shale of Great Valley sequence
682:	Mz-md	unnamed unit of Great Valley sequence
683:	Mz-sm	unnamed formations and undiv. rocks of Great Valley sequence
684:	Mz-md	siltstone and minor sandstone unit of Great Valley sequence
685:	Mz-md	upper part of Knoxville Fm (Robinson 1956) and part of shale unit
686:	Mz-md	Knoxville Fm
687:	Mz-md	mudstone and siltstone unit
688:	Mz-sm	shale unit

689:	Mz-md	shale unit including Knoxville Fm of Crittenden (1951)
700:	Mz-ms	unsheared sandstone and shale of Franciscan assemblage
701:	Mz-ms	sandstone and shale of Franciscan assemblage
702:	Mz-ms	flysch-like shale and sandstone of Franciscan assemblage
703:	Mz-ms	chiefly metagraywacke of Franciscan assemblage
704:	Mz-ms	Franciscan assemblage undiv.
800:	Mz-mm	severely sheared rocks of Franciscan assemblage
801:	Mz-mm	melange of largely clastic rocks of Franciscan assemblage
802:	Mz-mm	melange of metamorphic rocks of Franciscan assemblage
803:	Mz-mm	variably sheared sandstone and shale of Franciscan assemblage
804:	Mz-mv	variably sheared metagreenstone of Franciscan assemblage
805:	Mz-sp	sheared serpentinite
900:	Mz-sp	largely unsheared ultramafic rock and serpentinite
901:	Mz-sp	ultramafic rock
902:	Mz-bv	diabase and gabbro
903:	Mz-bv	diabase
904:	Mz-bv	diabase
905:	Mz-bv	diabase
906:	Mz-gr	granitic rocks
907:	Mz-gr	granitic rocks and minor gabbro
908:	Mz-sch	marble quartzite and schist
909:	Mz-ls	limestone of Franciscan assemblage including Calera Limestone of Lawson (1902)
910:	Tu-sc	silica-carbonate rock
911:	Mz-hg	high-grade metamorphic rocks of Franciscan assembla