U.S. DEPARTMENT OF THE INTERIOR
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GEOLOGY OF POINT REYES NATIONAL SEASHORE AND VICINITY, CALIFORNIA: A DIGITAL DATABASE

By

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Open - File Report 97-456

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This database, identified as "Geology of Point Reyes National Seashore and Vicinity, 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 Open-File report is a digital geologic map database. This pamphlet serves to introduce and describe the digital data. There is no paper map included in the Open-File report. The report does include, however, a PostScript plot file containing an image of the geologic map sheet with explanation, as well as the accompanying text describing the geology of the area. For those interested in a paper plot of information contained in the database or in obtaining the PostScript plot files, please see the section entitled "For Those Who Aren't Familiar With Digital Geologic Map Databases" below.

This digital map database, compiled from previously published and unpublished data and new mapping by the authors, represents the general distribution of surficial deposits and rock units in Point Reyes and surrounding areas. Together with the accompanying text file (pr-geo.txt or pr-geo.ps), it provides current information on the stratigraphy and structural geology of the area covered. The database delineates map units that are identified by general age and lithology following the stratigraphic nomenclature of the U.S. Geological Survey. The scale of the source maps limits the spatial resolution (scale) of the database to 1:48,000 or smaller. The content and character of the database, as well as three methods of obtaining the database, are described below.

For Those Who Aren't Familiar With Digital Geologic Map Databases

For those interested in the geology of Point Reyes who do not use an ARC/INFO compatible Geographic Information System (GIS), but would like to obtain the paper map with explanation, one PostScript plot file containing map images of much of the data in the digital database, as well as a PostScript plot file of the explanatory text, have been included in the database package (please see the section "PostScript Plot Files Package" page 6). However, the plot files do require uncompress and tar utilities to access the files.

Those interested who have computer capability can access the PostScript plot files or the digital dataset package in any of the three ways described below (please see the section "Obtaining the Plots from Postscript Files" page 6), including the Western Region Web Page (please see the section "Web Pages" page 7).

For those without computer capability, we have made the plot files available to an outside vendor, or we can provide users with the PostScript plot files on digital tape that can be used by other vendors (please see the section "Obtaining Plots from an Outside Vendor" page 5).

DATABASE CONTENTS

The first digital package consists of one PostScript plot file of the geologic map and explanation and the geologic description. A second digital database package consists of the geologic map database itself and the supporting data, including base maps, map explanation, geologic description, and references .

POSTSCRIPT PLOTFILE PACKAGE

The first digital data package (pr-map.tar.gz) contains the PostScript image described below:

pr-sheet1.ps	A PostScript plottable file containing an image of the geologic map and base maps of Point Reyes and Vicinity, includes the map key, correlation chart, and index map. at a scale of 1:48,000 (Sheet 1).
pr-geo.ps	A PostScript plot file of a report containing detailed unit descriptions and geological information, plus sources of data and references.

DIGITAL DATABASE PACKAGE

The second database package (pr-data.tar.gz) includes a geologic map database file for Point Reyes and vicinity. The digital maps, or coverages, along with their associated INFO directory have been converted to uncompressed ARC/INFO export files. ARC export files promote ease of data handling and are usable by some Geographic Information Systems in addition to ARC/INFO (see below for a discussion of working with export files). The ARC export files and the associated ARC/INFO coverages and directories, as well as the additional digital material included in the database package, are described below:

ARC/INFO export file	Resultant Coverage	Description of Coverage
pr-geol.e00	pr-geol	Depositional contacts, faults, and unit labels.
pr-strc.e00	pr-strc	Fold axes, strike and dip information.
pr-arrows.e00	pr-arrows	Landslide arrows.
pr-oil.e00	pr-oil	Oil well locations.
pr-topo.e00	pr-topo/	Topographic contours base map (from 1:48,000 scale originals).
pr-drain.e00	pr-drain/	Drainage base map (from 1:100,000 scale originals).
pr-outln.e00	pr-outln/	Outline of map boundary.

ASCII text files, including explanatory text, PostScript plot files, and an ARC Macro Language file for conversion of ARC export files into ARC coverages:

pr-geo.ps	A PostScript plot file of a report containing detailed unit descriptions and geological information, plus sources of data and references.
pr-geo.txt	A text-only file containing an unformatted version of pr-geo.ps

pr-db.ps	This file.
pr-db.txt	A text-only file containing an unformatted version of pr-db.ps
units.ps	A PostScript plot file of the map units and symbols from Sheet 1.
correl.ps	A PostScript plot file of the correlation chart that accompanies the map.
index.ps	A PostScript plot file of the index map that delineates the sources of data used in the making of the map.
oil.ps	A PostScript plot file of the oil test wells that accompanies the map.
import.aml	ASCII text file in ARC Macro Language to convert ARC export files to ARC coverages in ARC/INFO.

The following supporting directory is not included in the database package, but is produced in the process of reconverting the export files into ARC coverages:

info/	INFO directory containing files supporting the databases. This directory is not included in the database release, but is created in the process of converting the export files into ARC coverages.

Database Release Format

The database was compiled in ARC/INFO, a commercial Geographic Information System (Environmental Systems Research Institute, Redlands, California), and is stored in uncompressed ARC export format (ARC/INFO version 7) in a compressed UNIX tar (tape archive) file. Tar and uncompress utilities are therefore required to extract the database from the tar file. These utilities are included in most UNIX systems, and 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). The tar file was compressed with gzip and may be uncompressed with gzip, which is available free of charge via the Internet from the gzip Home Page (http://w3.teaser.fr/~jlgailly/gzip). ARC/INFO export files (files with the .e00 extension) can be converted into ARC/INFO coverages (see below) and can be read by some other Geographic Information Systems, such as MapInfo via ArcLink and ESRI's ArcView. The digital compilation was done using version 7.0.3 of ARC/INFO with version 3.0 of the menu interface ALACARTE (Fitzgibbon and Wentworth, 1991, Fitzgibbon, 1991, Wentworth and Fitzgibbon, 1991).

OBTAINING PLOTS WITHOUT A COMPUTER

Obtaining Plots from an Outside Vendor

For those interested in the geology of Point Reyes who do not use computers, we have made the PostScript plot files available to Capitol Color, 2250 Walsh Ave., Santa Clara (phone: (800) 700-2656 or (408) 727-7560, FAX: (408) 727-0737). They will provide plots of the PostScript image of the geologic map sheet and explanation for a fee (around $25 per sheet, with discounts for orders of multiple copies). We will also provide the PostScript plot files on digital tape for use by other vendors. A 6.9 MB compressed tar file (pr-map.tar.gz, 21.4 MB when uncompressed) of the PostScript plot files can be obtained by sending a tape with request and return address to:

Point Reyes National Seashore PostScript Plotfiles
c/o Database Coordinator
U.S. Geological Survey
345 Middlefield Road, MS 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.

Make sure your vendor is capable of reading these tape types and PostScript plot files. Important information regarding tape file format is included in the section "PostScript Plot Files" below, so be certain to provide a copy of this document to your vendor.

OBTAINING PLOTS FROM POSTSCRIPT FILES

PostScript Plot Files Package

For those interested in the geology of Point Reyes who don't use an ARC/INFO compatible GIS system, but would like to obtain the paper map with explanation, we have included a separate data package (pr-map.tar.gz) with one PostScript plot file and a second PostScript text file containing the geologic description and discussion. It contains a color plot of the geologic map database, map key, correlation chart, and index map at 1:48,000 scale (Sheet 1, pr-sheet1.ps).

This plot file is available in any of the three ways described below, including the World Wide Web pages. However, the plot file is stored in compressed UNIX tar files requiring uncompress and tar utilities to access the file. These utilities are included in most UNIX systems, or 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). The tar file was compressed with gzip, and may be uncompressed with gzip, which is available free of charge via the Internet from the gzip home page (http://w3.teaser.fr/~jlgailly/gzip).

The PostScript image of Sheet 1 is 34 inches wide by 44 inches high, so it requires a large plotter to produce paper copies at the intended scale. In addition to size constraints, some plotters, such as those with continual paper feed from a roll, are oriented with the long axis in the vertical direction, so the PostScript image will have to be rotated 90 degrees to fit entirely onto the page. Some plotters and plotter drivers, as well as many graphics software packages, can perform this rotation. The geologic description is on 8.5 by 11 inch pages. 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 may overlap. Sample plots by the authors, however, have proven to be quite legible and useful.

Obtaining the PostScript plotfile package

1. Sending a tape with request

A 6.9 MB compressed tar file of the plotfile and text can be obtained by sending a tape with request to:

Point Reyes National Seashore Geologic Database
c/o Database Coordinator
U.S. Geological Survey
345 Middlefield Road, MS 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.

2. Anonymous ftp over the Internet

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/open-file	-go down to the pub/open-file directory
cd of97-456	-go down to the open file directory
type binary	-change transfer type to binary
get pr-map.tar.gz	-copy the compressed tar file across Internet to your directory
quit	-close the ftp connection

3. From the Western Region Geologic Information Web Page.

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 server for digital publications from the Western Region is "http://wrgis.wr.usgs.gov". Once at the main page, click on 'Geologic Map Databases' under the heading 'Data Online'; next click on 'California.' Scroll down to the section for this database and click on the Open-File button to get to this publication's web page. Or go directly to this publication's web page: http://wrgis.wr.usgs.gov/open-file/of97-456. Set your web browser to save to a local disk and click on the link labeled 'pr-map.tar.gz' to download the compressed tar file that contains the Point Reyes geologic map and text.

Extracting The PostScript Plotfile package From The Tar File

1. If you obtained the plotfile package 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 being an integer, this puts the tar file in local_directory; 20 is the block size of the tar file
gzip -d pr-map.tar.gz	-makes a 21.4 MB uncompressed tar file pr-map.tar
cd local_directory2	-go to the directory that will hold the directory pr-map (if different from local_directory)
tar xvfb {path to tar file}/pr-map.tar 20	-extract the pr-map directory from the tar file.

2. If you obtained the database by anonymous ftp :

gzip -d pr-map.tar.gz	-makes a 21.4 MB uncompressed tar file pr-map.tar
cd local_directory2	-go to the directory that will hold the directory pr-map (if different from local_directory)
tar xvfb {path to tar file}/pr-map.tar 20	-extract the pr-map directory from the tar file.

This process will create a directory "/pr-map" that contains the PostScript plot files as described above.

3. If you obtained the database from the web:

gzip -d pr-map.tar.gz	-makes a 21.4 MB uncompressed tar file pr-map.tar
cd local_directory2	-go to the directory that will hold the directory pr-map (if different from local_directory)
tar xvfb {path to tar file}/pr-map.tar 20	-extract the pr-map directory from the tar file.

This process will create a directory "/pr-map" that contains the PostScript plot files as described above.

OBTAINING THE DIGITAL DATA

Digital Database Package

The digital database is in ARC export format and therefore requires use of ARC/INFO or another compatible GIS system to access and manipulate the information contained within it. The digital database package can be obtained in any of three ways:

1. Sending a tape with request

A 14.7 MB compressed tar file of the database and related files can be obtained by sending a tape with request to:

Point Reyes National Seashore Geologic Database
c/o Database Coordinator
U.S. Geological Survey
345 Middlefield Road, MS 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.

2. Anonymous ftp over the Internet

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/open-file	-go down to the pub/open-file directory
cd of97-456	-go down to the open file directory
type binary	-change transfer type to binary
get pr-data.tar.gz	-copy the compressed tar file across Internet to your directory
quit	-close the ftp connection

3. From the Western Region Geologic Information Web Page.

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 server for digital publications from the Western Region is "http://wrgis.wr.usgs.gov". Once at the main page, click on 'Geologic Map Databases'

under the heading 'Data Online'; next click on 'California.' Scroll down to the section for this database and click on the Open-File button to get to this publication's web page. Or go directly to this publication's web page: http//wrgis.wr.usgs.gov/open-file/of97-456. Set you web browser to save to a local disk and click on the link labeled 'pr-data.tar.gz' to download the compressed tar file that contains the Point Reyes geologic map database.

Extracting The Digital Database from the Tar file

1. If you obtained the database package 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 being an integer, this puts the tar file in local_directory; 20 is the block size of the tar file
gzip -d pr-data.tar.gz	-makes a 55 MB uncompressed tar file pr-data.tar
cd local_directory2	-go to the directory that will hold the directory pr-data (if different from local_directory)
tar xvfb {path to tar file}/pr-data.tar 20	extract the pr-data directory from the tar file.

2. If you obtained the database package by anonymous ftp :

gzip -d pr-data.tar.gz	-makes a 55 MB uncompressed tar file pr-data.tar
cd local_directory2	-go to the directory that will hold the directory pr-data (if different from local_directory)
tar xvfb {path to tar file}/pr-data.tar 20	-extract the pr-data directory from the tar file.

This process will create a directory "/pr-data" that contains the ARC export files and supporting files as described above in the database contents section.

3. If you obtained the database package from the web page:

gzip -d pr-data.tar.gz	-makes a 55 MB uncompressed tar file pr-data.tar
cd local_directory2	-go to the directory that will hold the directory pr-data (if different from local_directory)
tar xvfb {path to tar file}/pr-data.tar 20	-extract the pr-data directory from the tar file.

This process will create a directory "/pr-data" that contains the ARC export files and supporting files as described above in the database contents section.

Converting ARC export files

ARC export files are converted to ARC coverages using the ARC command IMPORT with the option COVER. In order to ease conversion and to maintain naming conventions, we have included an ASCII text file in ARC Macro Language that will convert all of the export files in the database into coverages and create the associated INFO directory. From the ARC command line type:

Arc: &run import.aml

ARC export files also can be read by some other Geographic Information Systems. Please consult your GIS documentation to see if you can use ARC export files and the procedure to import them.

ADDITIONAL INFORMATION

Digital Compilation

The geologic map information was digitized from stable originals of the geologic maps at 1:48,000 scale. A pencil on mylar overlay of the author manuscript were scanned using a Altek monochrome scanner with a resolution of 800 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 appropriate, and scanning artifacts visible at 1:48,000 were removed.

Base Maps

Base map layers were prepared from scale-stable printing negatives of the U.S. Geological Survey Point Reyes National Seashore and Vicinity, California 1:48,000 topographic map, which has an 80-foot contour interval and the U.S. Geological Survey Napa, California 1:100,000 drainage map. 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. Small mismatches at the boundaries caused by slight differences in the original scans remain in the two 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 development 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 landslides in the region. For a 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 1:48,000 means that higher resolution information is not present in the dataset. Plotting at scales larger than 1:48,000 will not yield greater real detail, although it may reveal fine-scale irregularities below the intended resolution of the database. Similarly, when 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 drainage layer has a resolution of 1:100,000, so significant discrepancies with the geologic coverages are possible. The base map layers are provided for reference only.

DATABASE SPECIFICS

The map databases consist of ARC coverages and supporting INFO files, which are stored in a Universal Transverse Mercator (California coordinate system) projection (Table 1). Digital tics define a 5.0-minute grid of latitude and longitude in the geologic coverages, corresponding with quadrangle internal tics.

Table 1 - *Map Projection*

PROJECTION UNIVERSAL TRANSVERSE MERCATOR	
UNITS METERS	-on the ground
ZONE 10	-Arc/Info UTM zone corresponding to California coordinate system zone 10
PARAMETERS	-none
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, 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.

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)
SEL	1	1	I	-	user defined field used to save a selected set
SYMB	3	3	I	-	user defined field used to save symbol assignments (such as color)

Table 4 - *Line Types Recorded in the LTYPE Field*

contact, certain
contact, concealed
contact, approx. located or gradational
contact, inferred
fault contact, certain
fault contact, concealed
fault contact, approx. located or gradational
fault contact, inferred
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).

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 pr-geo.txt or pr-geo.ps. Note that ARC/INFO coverages cannot contain both point and polygon information, so only coverages with polygon information will have a polygon attribute table, and these coverages will not have a point attribute table.

Table 5 - *Content of the Polygon Attribute Tables*

ITEM NAME	WIDTH	OUTPUT	TYPE	N. DEC	DESCRIPTION
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
SEL	1	1	I		user defined field used to save a selected set
SYMB	3	3	I		user defined field used to save symbol assignments (such as color)

Table 6 - *Map Units*
(See pr-geo.txt or pr-geo.ps for descriptions of units)

Qs	QTm	Kg
Qd	Twg	Kgr
Qal	Tp	Kqd
Qls	Tsc	KJf
Qod	Tsm	m
Qt	Tm	
Qoc	Tl	
Qmi	Tpr	

Points

Point information (strikes and dips) is recorded as coordinate and related information and are described in the Point Attribute Table (Table 7). Note the ARC/INFO coverages cannot contain both point and polygon information, so only coverages with point information (pr-strc) will have a point attribute table, and these coverages will not have a polygon attribute table. The features are recorded in the PTTYPE field according to the point types recorded in Table 8.

Table 7 - *Content of the Point Attribute Tables*

ITEM NAME	WIDTH	OUTPUT	TYPE	N. DEC	DESCRIPTION
AREA	4	12	F	3	this field is not used
PERIMETER	4	12	F	3	this field is not used
<coverage>#	4	5	B		unique internal control number
<coverage>-ID	4	5	B		unique identification number
PTTYPE	35	35	C		point type (see Table 8)
DIP	3	3	I		dip angle in degrees
STRIKE	3	3	I		strike angle in degrees

Table 8 - *Point types recorded in the PTTYPE field*

Anticline arrow
Approximate bedding
Bedding
Flat bedding
Overturned bedding
Syncline arrow
Vertical bedding

Acknowledgments

We are grateful to Don Lewis, former chief geologist of Chevron, for the release of well data and to Robert Fleisher also of Chevron for providing microfossil slides of Chevron Oil Company wells. We also are indebted to Kris McDougall for identifying and interpreting microfossils, to Martin Link for measuring and interpreting the sedimentology of the Kehoe Beach section, and to the late Clyde Wahrhaftig for enthusiastically supporting this work and for collaborating with us on two field trips in 1990 and 1991 to the Points Reyes area. LeeRoy Brock, former Chief Park Ranger of Point Reyes National Seashore, greatly facilitated our field work in 1978 and 1979.

Carolyn Randolph, Heather Schoonover, and Carl Wentworth developed this digital version of the geologic map, and Carolyn Randolph prepared the booklet announcing the release of this database in Open Files. Partial funding was provided to Clark by USGS NEHRP award number 1434-HQ-96-GR-02741.

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