DEPARTMENT OF THE INTERIOR
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THE SURFACE OF CRYSTALLINE BASEMENT, GREAT VALLEY AND SIERRA NEVADA, CALIFORNIA: A DIGITAL MAP DATABASE

by

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INTRODUCTION

Crystalline basement in central California extends westward from the exposed Sierra Nevada beneath the sedimentary fill of the Great Valley and under the eastern edge of the Coast Ranges at mid-crustal depth (figure 1, and see ccb_fig1.ps or ccb_fig1.pdf). The surface of this basement is defined from three types of control: in the Sierra Nevada from the topography itself, beneath the eastern two thirds of the Great Valley in considerable detail from numerous wells drilled for oil and gas, and beneath the western San Joaquin Valley in less detail from seismic reflection and refraction profiles. Together, these data demonstrate that the surface of crystalline rock is continuous from the exposed rock in the mountains to the top of high-velocity rock buried deep beneath the eastern front of the southern Coast Ranges.

This report presents a compilation of data through 1985 that define the surface of this crystalline basement, a contour map of the surface, and the lithology of the basement rock sampled by many of the wells. The compilation was begun as part of the investigation of the 1983 Coalinga earthquake (Wentworth and Zoback, 1990; Yerkes, Levine, and Wentworth, 1990), and was subsequently converted to digital form and extended to the whole of the Great Valley and Sierra Nevada. The main purpose was to explore and document the shape and continuity of the basement surface and to determine the relation of the surface to the tectonic wedge hypothesis (Wentworth and others, 1984; Wentworth and Zoback, 1989). Available basement samples from wells -- principally the thin-section collection of May and Hewitt (1948) preserved by the California Academy of Sciences -- were also reexamined by cooperating petrologists in an effort to distinguish wells that bottomed in ophiolitic rocks.

The preparation and content of the database are described herein. The digital database itself, consisting of five ARC/INFO coverages and equivalent sets of shape files, a table of wells, and this text, together with several ancillary files, can be obtained from the Web at URL http://pubs.usgs.gov/of/1995/96/ .

The database was originally compiled in pre-7.0 database format in ARC/INFO, a commercial Geographic Information System (Environmental Systems Research Institute [ESRI], Redlands, California), and is stored in uncompressed ARC/INFO export format in a UNIX tar file. Arc to shapefile conversion was accomplished using ArcInfo 9.1 in 2007.

OBTAINING THE DIGITAL DATA

The report, including text, database, and ancillary files, can be obtained from the U.S. Geological Survey publications server at:

http://pubs.usgs.gov/of/1995/96/

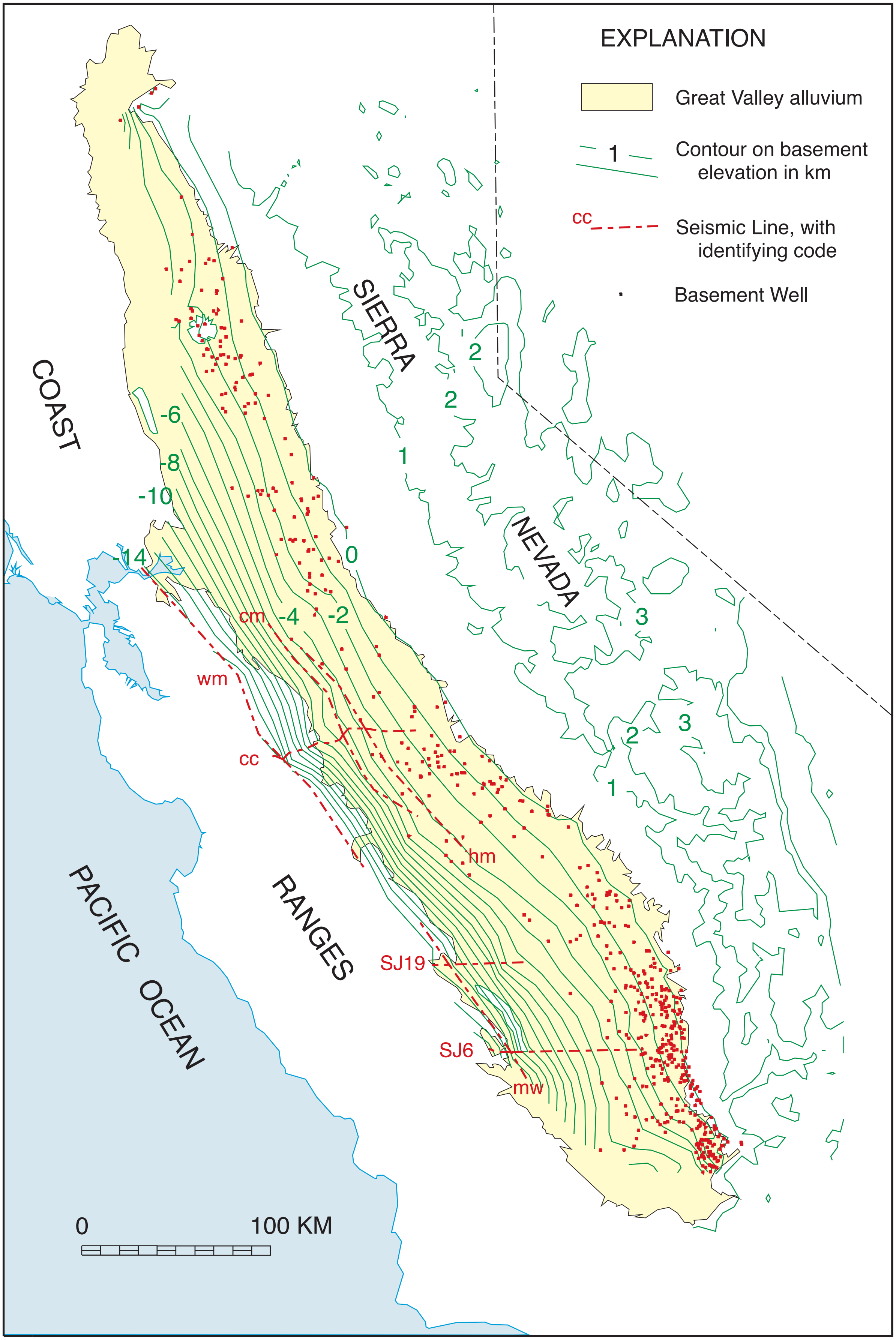

Figure 1. Summary map of basement surface contours, wells, and seismic lines, central California.

PROCESSING THE FILES

All the files have been assembled into a single compressed tar file named ccbsmt.tar.gz. This file must be uncompressed and the individual component files extracted using gzip or an equivalent utility. At that point, the ArcInfo coverages can be obtained by importing the Arc export files (.e00 files). The included import.aml will accomplish this (run from the Arc prompt), and at the same time allows deletion of the now imported e00 files.

CONTENTS OF REPORT

Processing of the compressed tar file (ccbsmt.tar.gz) will yield a suite of files, including Arc export files, shape files, text files, and a page-sized map, involving several file formats, as follows:

ccbsmt.text	- An ASCII file containing this text (without figure 1).
ccbsmt.ps	- Postscript version of this text (without figure 1).
ccbsmt.pdf	- pdf version of this text, including figure 1.
ccb_fig1.ps	- the original (1995) Postscript version of the summary map (figure 1).
ccb_fig1.pdf	- A colored version of figure 1 prepared (2007) from ccb_fig1.ps.
ccb_wells.ps	- Postscript tables of the basement and constraining wells.
ccb_wells.pdf	- Tables of the basement and constraining wells in pdf form.
ccb_wells.asc	- An ASCII version of ccb_wells.ps.
lam2dd.prj	- projection file used to convert coverages in Lambert projection to geographic coverages in decimal degrees, from which the shape files were prepared.
import.aml	- An AML to convert the following export files to coverages in ARC/INFO.

Coverage export files (with coverage names assigned by import.aml)

ccb-bwells.e00	- export file for the basement wells (ccb-bwells).
ccb- cont.e00	- export file for the basement contours (ccb- cont).
ccb-cwells.e00	- export file for the constraining wells (ccb- cwells).
ccb-qbndy.e00	- export file for the boundary of Quaternary alluvium in the Great Valley (ccb- qbndy).
ccb-seis.e00	- export file for the seismic lines and elevation points (ccb- seis).

Shape files

cb-bw	- files cb-bw.dbf, cb-bw.shp, cb-bw.shx (from ccb-bwells)
cb-cn	- files cb-cn.dbf, cb-cn.shp, cb-cn.shx (from ccb-cont)
cb-cw	- files cb-cw.dbf, cb-cw.shp, cb-cw.shx (from ccb-cwells)
cb-qb	- files cb-qb.dbf, cb-qb.shp, cb-qb.shx (from ccb-qbndy)
cb-sl	- files cb-sl.dbf, cb-sl.shp, cb-sl.shx (from ccb-seis)

Run the import.aml from the ARC prompt in ArcInfo to convert the export files to ArcInfo vector maps (coverages). Answer YES to the question "Delete export files after importing <rtn>=NO?" if you want to have the export files deleted once they are imported. Rerunning the aml will import any coverages not already converted and reoffer the option to delete any remaining export files.

SIERRAN TOPOGRAPHY

In the Sierra Nevada, crystalline rock is exposed at the ground surface in most places (Jennings, 1977). This part of the basement surface is represented by a smoothed version of the topographic surface based originally on the 1:250,000 altitude data of the Defense Department's Electromagnetic Compatibility Analysis Center (ECAC) described by Godson (1981). Godson prepared a dataset in which the ECAC altitudes were tested, edited, and averaged over 15-second cells (about half a km on a side) to produce a digital terrain model suitable for gravity data reduction. We, in turn, prepared a 2-km grid of altitudes sampled from this 15-second data in Lambert projection (table 2) to represent the top of crystalline rock east of the Great Valley.

This grid of average altitudes was supplemented along the western boundary of basement exposures in the Sierran foothills by representative spot elevations digitized from the 1:250,000 California geologic map (Matthews and Burnett, 1965; Smith, 1964; Strand, 1967; Wagner and others, 1981) to provide a seamless join between the topographic grid and subsurface data to the west. (Note that this western boundary of basement exposures is not everywhere coincident with the boundary of Quaternary alluvium in the Great Valley, because of the presence of intervening Tertiary sedimentary cover).

The resulting altitude grid was used in preparing contours of the basement surface (see below), but itself is not included in the database.

DRILL HOLES

A great number of wells have been drilled in the Great Valley of California in search of oil and gas. Some of these reach crystalline basement beneath the Cenozoic-Cretaceous sedimentary section, which is recognized by hard drilling, character on geophysical logs, and cuttings or core of crystalline rock. Smith (1964) compiled a map at a scale of 1:500,000 of about 250 basement wells and demonstrated a simple, west-dipping basement surface beneath the eastern half of the Great Valley. Maps at a scale of 1:250,000 were prepared of the basement surface in the northern San Joaquin Valley and in the Sacramento Valley by Bartow (1983) and Harwood and Helley (1987), respectively, using essentially the same well data as are used herein.

In the present work a file of 536 wells reaching crystalline basement in the Great Valley was compiled (ccb_bwells), using the work of Bartow, Harwood and Helley, and Yerkes and proceeding with searches of various reports of the California Division of Oil and Gas and of the Munger maps (Munger, 1985). The principal source was "Oil and Gas Prospect Wells Drilled in California Through 1980" and its supplements through 1985 (Hodgson, 1982). Other wells were obtained from files of the district offices of the Division of Oil and Gas (particularly Woodland) and from microfilm of CDOG records (Petroleum Information Corp. 1982). Our search was thorough in areas of sparse control, but additional basement wells exist in at least some areas, particularly where wells are numerous within developed fields. A file was also compiled of 42 wells that do not reach basement (ccb_cwells), but are deep enough to limit the position of the basement surface. These constraining wells were not used directly in contouring the basement surface. Some information for two deep wells in Naval Petroleum Reserve #1 in the Elk Hills was obtained from

Fishburn, 1990 (NAME = UONPR #1#987-25 and UONPR 934-29R).

The elevation of the top of basement in the basement wells was determined by subtracting the reported depth to basement (length of drill string) from the surface elevation of the well head (yielding negative values for elevations of the basement surface below sea level). The wells are assumed to have been drilled within a few degrees of vertical because of the nearly horizontal orientation of the strata penetrated and the general absence in the Great Valley of reason for wells to be directed away from the vertical. The well depths should generally be accurate to within a few meters. Bartow (1983) found close agreement between most reported basement depths and depths determined from electric logs and core descriptions for about 50 wells, with a few differing by as much as 10 m. The principal uncertainty in the basement elevations is whether the height of the drilling platform (Kelly bushing) above the ground surface (about 8 m) was subtracted from the reported surface elevations.

Some reported basement wells may actually have bottomed in an igneous intrusion, lava flow, or conglomerate within the sedimentary section above basement, or well below the top of crystalline rock (although most wells are not continued more than a few meters after encountering crystalline rock). Our principal test for these possibilities was reasonable consistency with basement depths in surrounding wells, and 8 of the basement wells were rejected on this basis (see Basement Wells).

The geographic locations of most of the wells were determined by digitizing well locations from oil and gas field maps (California Division of Oil and Gas, through 1985), which ranged in scale from 1:12,000 to 1:125,000. These maps were registered for digitizing using the coordinates of selected section corners determined graphically from 1:24,000 topographic maps. The locations of a few wells were more precisely determined by graphical plotting on the 1:24,000 quadrangles according to well-file descriptions. Checking of our digital locations suggests that about 90% of the wells are located within 0.4 km of the source-map locations (0.5 mm at 1:750,000), with the error probably due largely to distortions within the source maps.

SEISMIC PROFILES

The basement surface beneath the sedimentary cover of the Great Valley can be imaged by seismic reflection and refraction profiles. Two deeply penetrating seismic reflection profiles collected for the petroleum industry were purchased and several new reflection and refraction profiles were collected (or reinterpreted) by the USGS in the early 1980's to explore crustal structure beneath the western San Joaquin Valley (table 1), and these are used to extend the basement surface westward from drill control. The basement surface recognized in these profiles is consistent with its position recorded in deep wells near the shallow ends of the profiles, which gives confidence that a continuous surface is represented by the two kinds of data.

The presence of faults offsetting the basement surface is particularly well documented by a map at a scale of 1:126,720 showing acoustic basement in part of the southern San Joaquin Valley prepared from proprietary seismic reflection profiles (Western Geophysical Co., 1975). This map was not used in defining the basement surface for the present compilation.

Table 1. Seismic Profiles

Reflection and refraction profiles used in the basement compilation (see fig. 1 for locations).

CODE	DESCRIPTION
wm	a northwest-southeast refraction profile along the eastern Diablo Range originally collected by Stewart (1968) and reinterpreted by Walter and Mooney (1982) and Blumling and Prodehl (1983).
cc	an east-west reflection profile that crosses the west margin of the San Joaquin Valley (Wentworth and others, 1987).
cm	a northwest-southeast refraction profile along the deep axis of the San Joaquin Valley across reflection line cc (Colburn and Mooney, 1986).
hm	a northwest-southeast refraction profile along the deep axis of the San Joaquin Valley across reflection line cc (Holbrook and Mooney, 1987).
mw	a northwest-southeast refraction profile along the synclinal axis west of Kettleman Hills (Walter, 1990).
SJ-19	an east-west reflection profile across Coalinga anticline (Wentworth and Zoback, 1990) and a parallel refraction profile 5 km to the north of SJ-19 (Walter, 1990).
SJ-6	an east-west reflection profile that crosses the west margin of the San Joaquin Valley (Wentworth and others, 1983) and a coincident refraction profile (Walter, Mooney, and Wentworth, 1987).

Velocity models interpreted from the refraction profiles define three principal packages of rock: (a) sedimentary rocks beneath the Great Valley having seismic velocities ranging from 1.8 km/s at the surface to 2.8-4.8 km/s, and locally as high as 5.2 km/s, at the base of the section; (b) low-grade metamorphic rocks of the Franciscan Complex having velocities ranging from 4.8 to 5.8 and locally to 6.0 km/s; and (c) crystalline basement rocks having velocities typically greater than 6.0 km/s. The contrast in velocity between adjacent packages of rock is generally distinct. The basement surface is placed at the top of the high-velocity rock (greater than 6.0 km/s), whether overlain by rock with a velocity characteristic of sedimentary rock (beneath most of the Great Valley) or of Franciscan rock (beneath the western margin of the valley and under the Coast Ranges). No wells within the Great Valley reach demonstrable Franciscan rock. The occurrence and implications of Franciscan rock overlying crystalline basement beneath the western Great Valley is discussed elsewhere (Wentworth and others, 1984; Wentworth and Zoback, 1989 and 1990).

Ambiguity in defining the basement surface is possible where the velocity of the uppermost basement rock lies within the range of Franciscan velocities, as is the case for the upper 1-2 km of basement rock on refraction profile cm and part of hm. To the west, on reflection profile cc, the lower part of the 5.8 km/s layer that is considered Franciscan rock could include basement rock with a velocity indistinguishable from that of Franciscan rock. Any discrepancy in the identification of the basement surface here is probably small, however, relative to the depth of the surface and the general uncertainty of the velocity models.

The basement surface in the reflection profiles lies at the base of the layered reflective sequence, as is demonstrated where basement is within the reach of nearby wells. This surface can be correlated westward from such control across profiles cc and SJ-6, where it closely corresponds to the basement velocity boundary in the associated seismic refraction profiles. The basement surface along profile SJ-19 is based largely on the adjacent refraction line.

The elevations along these profiles that were used in defining the basement surface herein are recorded as points along the profiles (in the seismic profile map, ccb_seis). Their accuracy decreases with depth because of the necessary interpretation of travel times required to determine depth, and at mid-crustal depths may be uncertain by as much as 1 or 2 km (see, for example, Walter and Mooney, 1982).

GRIDDING AND CONTOURING

Points of elevation on the basement surface from the several sources were converted to a common projection (table 2) and gridded at 2-km rectilinear spacing by interpolation according to a procedure that constrains the resulting surface to be one of minimum total curvature (Briggs, 1974). This surface honors all control points spaced more widely than 2 km. Where the points are closer, the grid values specify a smooth surface that approximates the more closely spaced values. In merging the topographic and subsurface grids, precedence was given to the subsurface grid. The values on the resulting uniform grid were contoured by machine at an interval of 250 m. No interpretation was imposed on the contoured result other than removal of distorted contours beyond the limits of control.

The preparation of the grid by sampling at a spacing of 2 km (about 1 minute of latitude and longitude) realistically portrays features in the basement surface with characteristic wave lengths greater than about 10 km for which control exists. Those features with wave lengths between about 10 and 4 km (2 data points) are somewhat distorted, however, and those with shorter wave lengths are smoothed.

No account was taken in the gridding and contouring of abrupt steps or tears in the buried basement surface. Faults are known to offset the basement surface (for example, Western Geophysical Co., 1975), but the available well control on elevation of the basement surface is not sufficient to define the faults or the vertical separations across them. Steep slopes between data points may actually represent faults and smooth surfaces with little control may contain faults.

BASEMENT ROCK TYPES

Crystalline rock types reported to the California Division of Oil and Gas (Hodgson, 1982) for those wells that reach basement range from nonspecific 'basement' to rare petrographic identifications. Petrographic work on basement samples (largely thin sections) was carried out by May and Hewitt (1948) over the whole Great Valley and by Williams and Curtis (1977) in the vicinity of Sutter

Butte and Ross (1979) in the southeastern San Joaquin Valley. Later reconsideration of basement rock types included work by Harwood (Harwood and Helley, 1987). In the course of the present compilation, 110 of the thin sections collected by May and Hewitt and preserved by the California Academy of Sciences were reexamined by petrologists M.C. Blake Jr, D.S. Harwood, and A.S. Jayko of the U.S. Geological Survey. The basement lithologies reported herein (LITH, in ccb_bwells) are based first on these new identifications and the work of Harwood and Ross, and then on the identities recorded by Hodgson (1982) or other available sources (see SOURCE, in ccb_bwells). Ross's determinations (1979) are separately recorded (ROSS, in ccb_bwells), based on the May and Hewitt (1948) thin section listed in SOURCE or a well log description (log:). A thorough reevaluation of all previous work was not attempted.

DIGITAL FILES

The digital database consists of an ARC/INFO workspace containing a set of digital maps (ARC/INFO coverages ccb_cont, ccb_bwells, ccb_cwells, ccb_qbndy, and ccb_seis) and postscript and ASCII tables of basement and constraining wells. The maps are stored in Lambert Conformal Conic projection (table 2) using the standard parallels for the conterminous United States (Snyder, 1987, p. 104) and local central meridian and base latitude.

Table 2a. Map Projection for ArcInfo Coverages

Projection	LAMBERT
Datum	NAD27
Units	METERS
Spheroid	CLARKE1866
Xshift	0.0000000000
Yshift	0.0000000000
Parameters	
33 0 0.000	- 1st standard parallel
45 0 0.000	- 2nd standard parallel
-120 0 0.000	- central meridian
0 0 0.000	- latitude of projection's origin
0.00000	- false easting (meters)
0.00000	- false northing (meters)

Table 2b. Map Projection for Shape Files

Projection	GEOGRAPHIC
Datum	NAD27
Units	DD (= decimal degrees)
Spheroid	CLARKE1866
Xshift	0.0000000000
Yshift	0.0000000000
parameters	

Digital tics define a 1-degree grid of latitude and longitude in each map, the southeastern corner of which is located at latitude 34, longitude -117 (NAD27). The contents of the database are described below in terms of the lines, polygons, and points that compose the maps. Descriptions of the database fields use the terms of table 3. Well information is included in the wells databases, but is also presented as text tables (ccb_wells.pdf, ccb_wells.ps, and ccb_wells.asc). Township/Range locations are relative to the Mt. Diablo Baseline and Meridian.

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

Basement Wells

The 536 wells in the Great Valley determined to reach crystalline basement beneath the sedimentary cover are stored as points in the basement wells map ccb_bwells. Point attributes describe basement elevation, geographic location of the points, identity of the wells, and basement lithology and its source (table 4, and see table 5 for sources of lithologic identities). The 8 rejected basement wells can be identified by the absence of reported basement lithology and a CCB_BWELLS-ID value of -1. Datum for longitude and latitude is NAD27.

Table 4. Content of the Point Attribute Table CCB_BWELLS.PAT

ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	
AREA	4	12	F	3	not used for points
PERIMETER	4	12	F	3	not used for points
CCB_BWELLS#	4	5	B	-	unique internal control number
CCB_BWELLS-ID	4	5	B	-	unique identification number, except = -1 for rejected wells
ELEV	6	6	I	-	elevation of basement surface in well, meters
TRS	12	13	C	-	township, range, and section
OWNER	36	36	C	-	recorded owner of well
NAME	34	34	C	-	recorded name of well
LAT	4	12	F	3	latitude, decimal degrees
LONG	4	12	F	3	longitude, decimal degrees
STATION	10	10	C	-	reference to original card file of wells
LITH	35	35	C	-	lithology of basement rock

SOURCE	35	35	C	-	source of lithologic identification
ROSS	35	35	C	-	lithology of basement rock from Ross, 1979
TR01	3	3	I	-	page reference in Hodgson, 1982
COMMENT	50	50	C	-	comment about above entries; number of May and Hewitt (1948) thin section.

Table 5. Meaning of SOURCE Entries in CCB_BWELLS.PAT

SOURCE	EXPLANATION
Bartow	Well file collection of J.A. Bartow, U.S. Geological Survey, consisting largely of geophysical logs and reports from DOG District Office files.
Blake	petrographic examination by M.C. Blake Jr., U.S. Geological Survey, of thin section(s) numbered (M-H nnn) in the collection of May and Hewitt, 1948, or sample and-or sections obtained by the USGS.
DOG	listing in Hodgson, 1982 (and see TR01)
DOG Woodland	files of DOG District 6 office in Woodland, CA
Harwood	oral commun., D.S. Harwood, U.S. Geological Survey, based on examination of thin section.
Harwood, PP Map	Lithologic category from map in Harwood and Helley, 1987
Jayko	petrographic examination by A.S. Jayko, U.S. Geological Survey, of thin section(s) numbered (M-H nnn) in the collection of May and Hewitt, 1948
Ross	Ross, 1979, based on May and Hewitt (1948) thin section listed in SOURCE or a well log description (log)
Saleeby	oral commun. to M.C. Blake Jr. by J.B. Saleeby, California Institute of Technology
Williams and Curtis	Williams and Curtis, 1977
Yerkes	Yerkes and others, 1990, #nnn = well number in their table 13.1
unknown	no record of source (basement lithology recorded, but not source)

Constraining Wells

The 42 wells compiled that are deep enough to help constrain the elevation of the basement surface are stored as points in the constraining wells map ccb_cwells. Point attributes describe elevation of the well bottom, geographic location of the points, and identity of the wells (table 6). Datum for longitude and latitude is NAD27.

Table 6. Content of the Point Attribute Table CCB_CWELLS.PAT

ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	
AREA	4	12	F	3	not used for points
PERIMETER	4	12	F	3	not used for points

CCB_CWELLS#	4	5	B	-	unique internal control number
CCB_CWELLS-ID	4	5	B	-	unique identification number
ELEV	6	6	I	-	elevation of bottom of well, meters
TRS	12	13	C	-	township, range, and section
OWNER	36	36	C	-	recorded owner of well
NAME	34	34	C	-	recorded name of well
LAT	4	12	F	3	latitude, decimal degrees
LONG	4	12	F	3	longitude, decimal degrees
STATION	10	10	C	-	reference to original card file of wells

Seismic Profiles

The locations of the 7 reflection and-or refraction profiles and the 50 points of basement elevation along them are stored as lines and points in the seismic profile map ccb_seis. The codes used to identify the seismic lines (table 7) are explained in table 1. Attributes of the elevation points describe basement elevation, geographic location, and the seismic profile from which they were determined (table 8).

Table 7. Content of the Arc Attribute Table CCB_SEIS.AAT

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	-	not used for these lines
RPOLY#	4	5	B	-	not used for these lines
LENGTH	4	12	F	3	length of arc in meters
CCB_SEIS#	4	5	B	-	unique internal control number
CCB_SEIS-ID	4	5	B	-	unique identification number
SEISLINE	6	6	C	-	identity code for seismic line (see table 1)

Table 8. Content of the Point Attribute Table CCB_SEIS.PAT

ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	
AREA	4	12	F	3	not used for points
PERIMETER	4	12	F	3	not used for points
CCB_SEIS#	4	5	B	-	unique internal control number
CCB_SEIS-ID	4	5	B	-	unique identification number
ELEV	6	6	I	-	elevation of basement surface at point, meters
SEISLINE	6	6	C	-	identity code for seismic line on which point is located (see table 1)

Basement Contours

Contours on the basement surface are stored in the contour map ccb_cont. Line attributes (table 9) describe basement elevation (index contours only) and identify index contours and those contours containing closed depressions (which lie to the left of such lines).

Table 9. Content of the Arc Attribute Table CCB_CONT.AAT

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	-	no associated polygon database
RPOLY#	4	5	B	-	no associated polygon database
LENGTH	4	12	F	3	length of arc in meters
CCB_CONT#	4	5	B	-	unique internal control number
CCB_CONT-ID	4	5	B	-	unique identification number
ELEV	6	6	I	-	elevation value of index contour in meters, value of 1 for intermediate contours
INDEX	1	1	I	-	= 1 for index contour (1000 m interval)
HACH	1	1	I	-	= 1 for closed depression

Quaternary Boundary

The boundary of Quaternary alluvium that fills the Great Valley, digitized from the State geologic map at 1:750,000 (Jennings, 1977), helps define the setting of the wells. Lines (table 10) include two types (LTYPE): 'contact, quat' for the alluvial boundary and 'scratch boundary' for an arbitrary closure of the alluvial area near Carquinez Strait to complete the polygon. The polygon contained by these lines is defined with PTYPE of Qal (table 11).

Table 10. Content of the Arc Attribute Table CCB_QBNDY.AAT

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	-	not used for these lines
RPOLY#	4	5	B	-	not used for these lines
LENGTH	4	12	F	3	length of arc in meters
CCB_QBNDY#	4	5	B	-	unique internal control number
CCB_QBNDY-ID	4	5	B	-	unique identification number
LTYPE	35	35	C	-	kind of line (see text)

Table 11. Content of the Polygon Attribute Table CCB_QBNDY.PAT

ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	
AREA	4	12	F	3	area of polygon, square meters
PERIMETER	4	12	F	3	length of polygon perimeter, meters
CCB_QBNDY#	4	5	B	-	unique internal control number
CCB_QBNDY-ID	4	5	B	-	unique identification number
PTYPE	35	35	C	-	= Qal for alluvial area

Conversion from the ArcInfo coverages to shape files involved two steps. First, the coverages were reprojected to geographic projection in decimal degrees (see table 2b) and at the same time assigned shorter, 5 character names, and then those coverages were converted to shape files with the ArcInfo ARCSHAPE command. See table 12 for details of the arc to shapefile conversion.

Table 12. Conversion of Coverages to Shape Files

The ARCSHAPE command with arguments (arcshape <coverage> <feature> <shape name>) is followed by the details reported for each conversion.

```
arcshape cb-bw point cb-bw
    INFO item name CB-BW# modified to dBASE field CB_BW_
    INFO item name CB-BW-ID modified to dBASE field CB_BW_ID
    INFO table CB-BW.pat copied to dBASE database .\cb-bw.DBF
    Fields: 16, Records: 536

arcshape cb-cn arc cb-cn
    INFO item name FNODE# modified to dBASE field FNODE_
    INFO item name TNODE# modified to dBASE field TNODE_
    INFO item name LPOLY# modified to dBASE field LPOLY_
    INFO item name RPOLY# modified to dBASE field RPOLY_
    INFO item name CB-CN# modified to dBASE field CB_CN_
    INFO item name CB-CN-ID modified to dBASE field CB_CN_ID
    INFO table CB-CN.aat copied to dBASE database .\cb-cn.DBF
    Fields: 10, Records: 662

arcshape cb-cw point cb-cw
    INFO item name CB-CW# modified to dBASE field CB_CW_
    INFO item name CB-CW-ID modified to dBASE field CB_CW_ID
    INFO table CB-CW.pat copied to dBASE database .\cb-cw.DBF
    Fields: 11, Records: 42

arcshape cb-qb arc cb-qb
    INFO item name FNODE# modified to dBASE field FNODE_
```

INFO item name TNODE# modified to dBASE field TNODE_
INFO item name LPOLY# modified to dBASE field LPOLY_
INFO item name RPOLY# modified to dBASE field RPOLY_
INFO item name CB-QB# modified to dBASE field CB_QB_
INFO item name CB-QB-ID modified to dBASE field CB_QB_ID
INFO table CB-QB.aat copied to dBASE database .\cb-qb.DBF
Fields: 8, Records: 8

arcshape cb-sl arc cb-sl
INFO item name FNODE# modified to dBASE field FNODE_
INFO item name TNODE# modified to dBASE field TNODE_
INFO item name LPOLY# modified to dBASE field LPOLY_
INFO item name RPOLY# modified to dBASE field RPOLY_
INFO item name CB-SL# modified to dBASE field CB_SL_
INFO item name CB-SL-ID modified to dBASE field CB_SL_ID
INFO table CB-SL.aat copied to dBASE database .\cb-sl.DBF
Fields: 8, Records: 7

Well Tables

Tables of the basement wells and the constraining wells are stored as pdf and postscript files ready for printing (ccb_wells.ps). Table entries are organized by one-degree quadrangles of latitude and longitude and describe identity of the wells, geographic location, and elevation of the basement surface or well bottom. ASCII versions of the tables are also provided for manipulation by computer.

SPATIAL RESOLUTION

Uses of this digital database should be designed to avoid violating the spatial resolution of the data. Although the digital form of the data removes the constraint imposed by the scales of paper maps, the detail and accuracy inherent in map scale are also present in the digital data. The data were compiled for use at 1:750,000, the scale of the State geologic map (Jennings, 1977), and use at larger scales will not yield greater real detail, although irregularities below the intended resolution of the database may be evident. Most of the wells are located within about 0.4 km on the ground, but some are more poorly located. The gridding of the control points at 2-km spacing assures that details on the basement surface with characteristic wave lengths less than 4 km are smoothed over, and those with wave lengths less than 10 km are distorted. 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 database.

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