# APPENDIX A: DAILY FIELD REPORTS (ELECTRONIC APPENDIX)

## SUMMARY

Appendix A includes digital copies of handwritten daily field reports generated by Geologic Mapping Project teams during field exercises in July and August 2012 and February 2013. The field reports include notes for the day's geologic mapping exercise(s) and documentation of daily field equipment verification. Files are labeled by field work instruction number "WI.XX" and month/day date. The digital files are in PDF format, as follows:

- Daily_Field_Rpt_WI.01_0709.pdf
- Daily_Field_Rpt_WI.01_0710.pdf
- Daily_Field_Rpt_WI.01_0711.pdf
- Daily_Field_Rpt_WI.02_0711.pdf
- Daily_Field_Rpt_WI.02_0712.pdf
- Daily_Field_Rpt_WI.03_0712.pdf
- Daily_Field_Rpt_WI.03_0713.pdf
- Daily_Field_Rpt_WI.04_0801.pdf
- Daily_Field_Rpt_WI.04_0802.pdf
- Daily_Field_Rpt_WI.06_0730.pdf
- Daily_Field_Rpt_WI.06_0731.pdf
- Daily_Field_Rpt_WI.07_0711.pdf
- Daily_Field_Rpt_WI.07_0713.pdf
- Daily_Field_Rpt_WI.07_WI.09_0712.pdf
- Daily_Field_Rpt_WI.08_0801.pdf
- Daily_Field_Rpt_WI.10_0710.pdf
- Daily_Field_Rpt_WI.11_0802.pdf
- Daily_Field_Rpt_WI.12_0802.pdf
- Daily_Field_Rpt_WI.13_0801.pdf
- Daily_Field_Rpt_WI.13_0802.pdf
- Daily_Field_Rpt_WI.15_0730.pdf
- Daily_Field_Rpt_WI.15_0803.pdf
- Daily_Field_Rpt_WI.16_0730.pdf
- Daily_Field_Rpt_WI.16_0731.pdf
- Daily_Field_Rpt_WI.17_0731.pdf
- Daily_Field_Rpt_WI.27_0204.pdf
- Daily_Field_Rpt_WI.27_0205.pdf
- Daily_Field_Rpt_WI.27_0206.pdf

- Daily_Field_Rpt_WI.27_0207.pdf
- Daily_Field_Rpt_WI.27_0208.pdf (last in list)

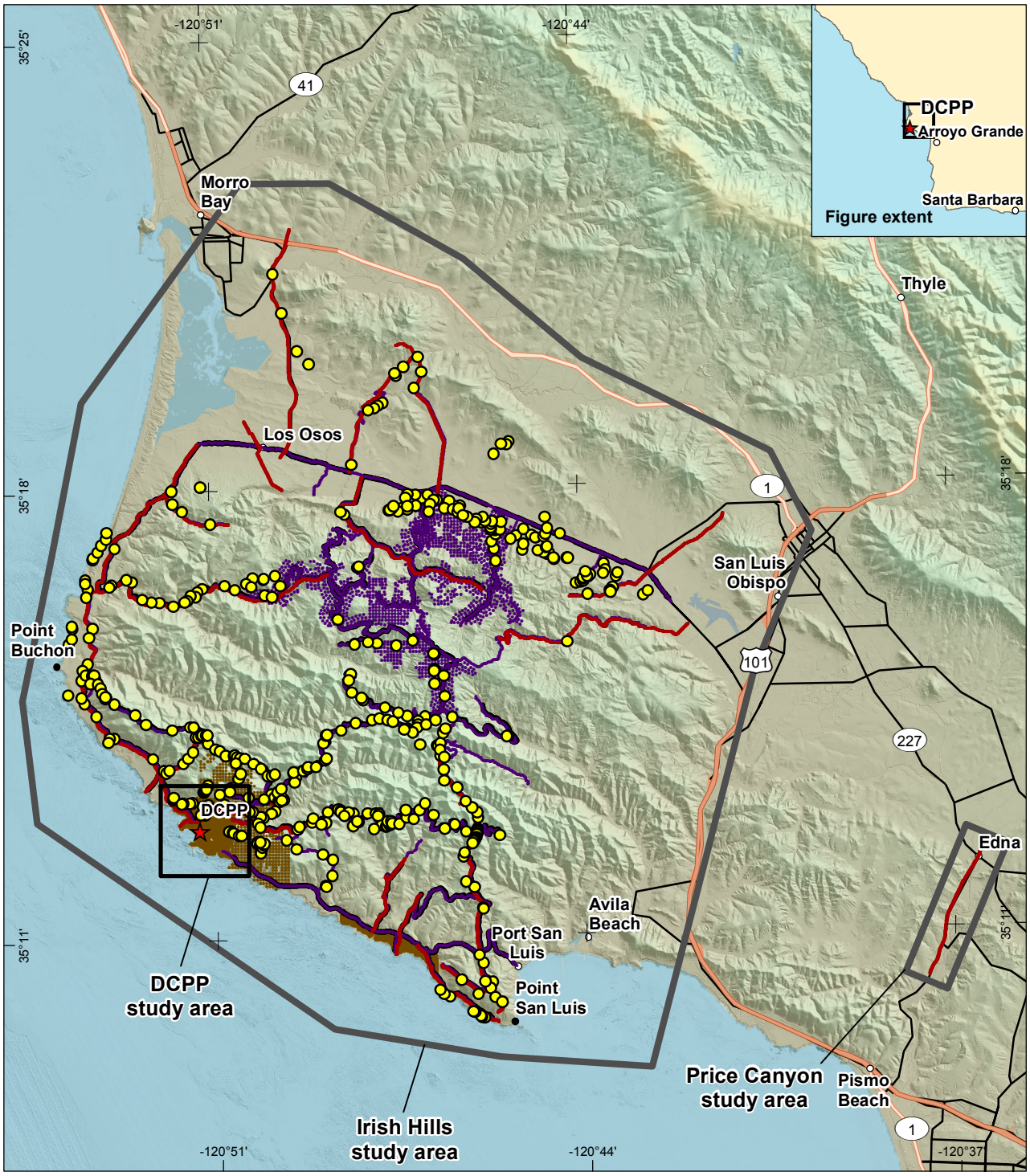
# APPENDIX B: FIELD PHOTOGRAPHS (ELECTRONIC APPENDIX)

## SUMMARY

Appendix B contains field photographs taken by Geologic Mapping Project (GMP) geologists during field mapping in July and August 2012 and February 2013. A GIS shapefile of all GMP field stations (Strike_Dip_Field_GMP.shp) contains links between field station locations and photographs. Photographs are named by the last initials of the mapping group members followed by the photo number assigned by the camera. A duplicate set of photographs is included and is grouped by work instruction number followed by year, month, and day for cross-referencing with the daily field reports in Appendix A. Figure B-1 shows the locations of field photographs.

Appendix B includes a Readme text file with instructions for linking field photographs to GIS field station points. Except for the Readme file, which is in TXT format, all files are in JPG format, as follows:

- GIS_Linked_Photos
- WI01_20120709
- WI01_20120710
- WI01_WI02_20120711
- WI02_WI03_20120712
- WI03_20120713
- WI04_20120801
- WI04_20120802
- WI06_20120730
- WI06_20120731
- WI07_20120711
- WI07_20120713
- WI07_WI09_20120712
- WI08_20120801
- WI10_20120710
- WI11_WI12_20120802
- WI13_20120801
- WI13_20120802
- WI15_20120730
- WI15_20120803
- WI16_20120730
- WI16_20120731
- WI17_20120731
- WI27_20130208 (last in list)




**EXPLANATION**

- Photograph location

**Seismic Reflection Survey**

- 2011 AWD line
- 2011 AWD line and 2011 Vibroseis line
- 2011 Vibroseis line
- 2011 nodal receivers, no shotpoints
- 2011 nodal receiver array
- 2012 high-resolution survey receiver array

N

0 2 4 mi.

0 4 8 km

Map projection and scale: NAD 83 / UTM Zone 10N, 1:175,000

# Locations of Photographs

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **B-1**

File path: S:\1005\020\QA_GIS\Final_Figures\Figure_B-1.mxd; Date: 06/03/2014; User: Alex Remar, LCI

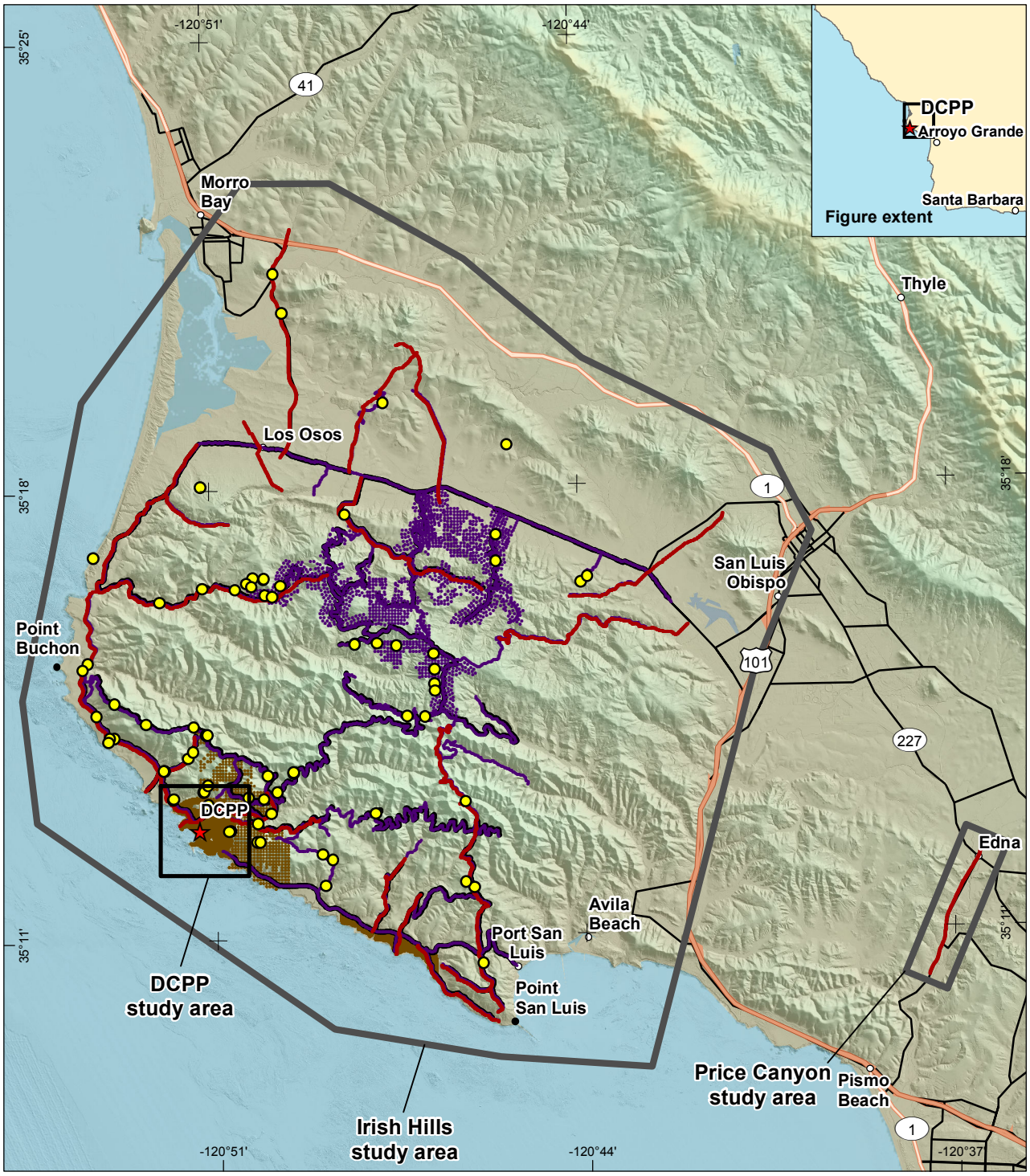
# APPENDIX C: FIELD SAMPLES (ELECTRONIC APPENDIX)

## SUMMARY

Appendix C contains a spreadsheet of field samples collected by Geologic Mapping Project (GMP) geologists during field mapping in July and August 2012 and February 2013. The GIS shapefile of GMP field stations (Strike_Dip_Field_GMP.shp) includes in the attribute table whether a sample was collected. All field hand samples are being kept in the basement storage space at Lettis Consultants International's (LCI) offices in Walnut Creek. The hand samples will be retained for the duration of the seismic interpretation project, and will then be discarded. Figure C-1 shows the locations of field hand samples.

Appendix C consists of two digital files, as follows:

- FieldSamples.xls (Excel file)
- Readme.txt (Text file)




**EXPLANATION**

- Sample location

**Seismic Reflection Survey**

- 2011 AWD line
- 2011 AWD line and 2011 Vibroseis line
- 2011 Vibroseis line
- 2011 nodal receivers, no shotpoints
- 2011 nodal receiver array
- 2012 high-resolution survey receiver array

N

0 2 4 mi.

0 4 8 km

Map projection and scale: NAD 83 / UTM Zone 10N, 1:175,000

# Locations of Hand Samples

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **C-1**

File path: S:\1005\020\QA_GIS\Final_Figures\Figure_C-1.mxd; Date: 06/03/2014; User: Alex Remar, LCI

# APPENDIX D: GIS FILES AND LAYERS (ELECTRONIC APPENDIX)

## SUMMARY

Appendix D consists of electronic files and this document summarizing the GIS data. The electronic GIS files are those used to make the geologic maps for the Irish Hills study area (Plate 1), Diablo Canyon Power Plant (DCPP) study area (Plate 2) and Price Canyon study area (Figure 3-9). This document describes the GIS files and GIS layers used to create the three maps. We first describe the GIS files and then the GIS layers.

### *GIS File Descriptions*

The electronic portion of Appendix D includes ArcGIS map document files (*.mxd), shapefiles (*.shp), geodatabase files (*.gdb), and georeferenced raster files (*.tif and *.jp2) used to display all data presented on the geologic maps of the three study areas (Plate 1, Plate 2, and Figure 3-9). Shapefiles, geodatabase files, and georeferenced raster files are defined in the North American Datum 1983 (NAD 83) UTM Zone 10N coordinate system. Metadata were generated for each file and include the following descriptions:

- data type
- data source
- purpose of the data
- time and date of data creation
- creator of the data
- the standards used to create the data, including data projection

The map document files and the relevant study area are listed in Table D-1:

**Table D-1. ArcGIS Map Document Files**

| File Name | Study Area (and Plate or Figure Number) |
|---|---|
| GMP_GIS_Package_Plate_1.mxd | Irish Hills (Plate 1) |
| GMP_GIS_Package_Plate_2.mxd | DCPP (Plate 2) |
| Figure_03-9.mxd | Price Canyon (Figure 3-9) |

The shapefiles, geodatabase files, and raster files used to create Plates 1 and 2 and Figure 3-9 can be grouped into *geology* files and *geography* files. Tables listing these files are on the subsequent pages.

Table D-2 lists the geology files, a summary of their contents, and the study area geologic maps that use the geology files. These files are the primary focus of the GMP.

**Table D-2. Geology Shapefiles and Geodatabase Files Used to Create the Geologic Maps**

| File Name | Description | Area of Relevance |
|---|---|---|
| Wells_GMP.shp | Point shapefile containing locations and information for deep oil and hydrogeologic wells in the study areas; Discussed in Appendix E | Plate 1 and Figure 3-9 |
| Geology_Compilation_ GMP.shp | Polygon shapefile of geologic units | Plates 1 and 2 and Figure 3-9 |
| Geology_Compilation_ Contacts_GMP.shp | Polygon shapefile of geologic units according to the stratigraphy used on Plate 1 and Figure 3-9 | Plate 1 and Figure 3-9 |
| DCPP_Site_Map_Contacts_ GMP.shp | Line shapefile of geologic contacts for Plate 2 | Plate 2 |
| Geology_Compilation_Anno_ 24k_GMP.gdb | Annotation geodatabase file to label geologic units on Plate 1 and Figure 3-9 | Plate 1 and Figure 3-9 |
| Geology_DCPP_Site_Anno_ 3k_GMP.gdb | Annotation geodatabase file to label geologic units on Plate 2 | Plate 2 |
| Fault_Fold_Compilation_ GMP.shp | Line shapefile of faults, folds, and lineaments | Plates 1 and 2 and Figure 3-9 |
| Strike_Dip_Compilation_ GMP.shp | Point shapefile of bedding attitudes and outcrop-scale faults compiled from various sources | Plates 1 and 2 and Figure 3-9 |
| Strike_Dip_Field_GMP.shp | Point shapefile with field records from GMP, including bedding attitudes, photograph and sample locations, and outcrop-scale faults, shears, and folds | Plates 1 and 2 |

Table D-3 lists the geography files, a summary of their contents, and the study area geologic maps that use the files. Files from sources other than the GMP are indicated and are not included in the digital database. The non-GMP sources are listed in the footnotes below the table.

**Table D-3. Geography Shapefiles, Geodatabase File, and Raster Files Used to Create the Geologic Maps**

| File Name | Description | Area of Relevance |
|---|---|---|
| Extent_of_Plates.shp | Polygon shapefile showing extents of Plates 1 and 2 | Plates 1 and 2 (inset maps) |
| Index_map.tif | Raster image of the DCPP-vicinity geography | Plates 1 and 2 and Figure 3-9 (inset maps) |
| DCPP_Site.shp | Point shapefile with the location of DCPP | Plate 1 and Figure 3-9 inset map |
| Study_Area_Boundary.shp | Polygon shapefile showing extent of Irish Hills study area | Plate 1 |
| Coastline_from_CA_Coastal_LiDAR.shp | Line shapefile showing approximate low tide line along coast | Plates 1 and 2 |
| Study_Area_Location_Names.shp | Point shapefile with names of key geographic locations | Plates 1 and 2 |
| Roads.shp | Line shapefile with DCPP roads | Plate 2 |
| Buildings.shp | Polygon shapefile with DCPP buildings | Plate 2 |
| Composite_HS_2013_07_UTM_NAD83_1m_315deg.jp2 | Raster hillshade image created from 1 m composite lidar-MBES DEM; artificial sun azimuth 315°, inclination 45° | Plates 1 and 2 and Figure 3-9 |
| Composite_DEM_2013_07_UTM_NAD83_contours.gdb | Geodatabase containing 10 m and 100 m contours generated from 1 m composite lidar-MBES DEM | (not shown on any figures) |
| Laguna_Lake.shp[†] | Polygon shapefile showing extent of Laguna Lake | Plate 1 |
| City_Points.shp | Point shapefile with names of local cities and towns | Plate 1 and Figure 3-9 |
| Major_Highways.shp[††] | Line shapefile showing major roadways | Plate 1 |

[†] City of San Luis Obispo GIS file obtained from the SLO DataFinder website (http://lib.calpoly.edu/gis/).

[††] From ESRI Data and Maps and StreetMap North America for ArcGIS 10.2 Basemap Database (DVD set provided by ESRI that accompanies ArcGIS licenses).

### *GIS Layer Descriptions*

Each map document file (*.mxd) consists of a series of layers. The layers are manipulations of the shapefiles, geodatabase files, and raster files to display selected information seen on the geologic maps. For each layer, a Layer Properties window shows information about the layer including the scale, source data, symbology, labels, and a definition query that can be used to filter the source data. The following subsections briefly discuss the layers within each study area geologic map, but we note that much of this information can be obtained within the Layer Properties window.

## IRISH HILLS STUDY AREA (PLATE 1)

Map document file name: GMP_GIS_Package_Plate_1.mxd.

Brief descriptions of each layer included in the Plate 1 map document file are listed below.

Layers for the Inset:

- *Extent_of_Plates*: Shows the extent of Plate 2 on the Plate 1 inset map. Uses the polygon shapefile Extent_of_Plates.shp. No transparency, special symbology, or label used. Definition query, "Name" = 'Extent of Plate 2', used.
- *Index_map.tif*: Shows simple geography of the DCPP vicinity for geographic reference on the Plate 1 inset map. Uses Index_map.tif.

Layers for the Main Map:

- *DCPP_Site*: Shows the location of the DCPP site. It was created for the purposes of GIS projects and map figures for scales approximately 1:12,000 and smaller. The layer uses DCPP_Site.shp. No transparency, special symbology, definition query, or label used.
- *Annotation_24K*: This annotation geodatabase includes geologic map symbols and lead lines to accompany Plate 1 and Figure 3-9. Uses geodatabase file Annotation_24K.gdb. No transparency, definition query, or label used.
- *Wells_GMP*: Shows the location of oil and hydrogeologic wells considered for the GMP for geologic information and/or considered for seismic-reflection data processing for sonic log information. The layer uses the point shapefile Wells_GMP.shp. Layer symbology differentiates on “WELL_TYPE” attribute field between oil and gas wells (red) and hydrogeologic boreholes/well (blue). Layer is labeled based on “WELL_NAME” attribute field. No transparency or definition query used.
- *Laguna_Lake*: Shows the location of Laguna Lake, based on the polygon shapefile Laguna_Lake.shp. The shapefile was downloaded by LCI from the Cal Poly SLO DataFinder website. No transparency, special symbology, definition query, or label used.
- *Study area boundary*: Shows the total area of the GMP. Uses polygon shapefile Study_Area_Boundary.shp. It contains two non-adjoining polygons: a larger one for the Irish Hills study area and a smaller one for the Price Canyon study area.

The DCPP study area is located entirely within the Irish Hills study area and its boundary is defined in a separate shapefile (Extent_of_Plates.shp). No transparency, special symbology, definition query, or label used.

- *Plate 1 Geology*: This group layer contains the following 7 layers:
- *GMP_FieldStations_All_GMP*: This layer is unselected for the Plate 1 display, but when selected will show locations of field stations recorded by GMP geologists. Layer source is Strike_Dip_Field_GMP.shp.
- *Strike_Dip_Field_GMP*: Shows bedrock structural measurements (bedding attitudes, local faults) collected during 2012 and 2013 GMP field mapping. The layer uses the point shapefile Strike_Dip_Field_GMP.shp. No transparency is used. The layer is symbolized on the attribute field "Type." Symbology is based on USGS map standards and comes from the style file, "FGDC_CGS_20100414.style." GMP field measurements are distinguished from previously-compiled structural attitudes by the white halo that outlines each attitude and associated label. A definition query with a "Yes" in the "Display" attribute field selects the subset of measurements that can be displayed on Plate 1 without obscuring information due to overcrowding. The layer is labeled by the attribute field "Dip_Plunge."
- *Strike_Dip_Compilation_GMP*: Shows bedrock structural measurements (bedding attitudes, local faults) compiled from existing data sets for the GMP. The layer uses the point shapefile Strike_Dip_Compilation_GMP.shp. No transparency is used. The layer is symbolized on the attribute field "Type." Symbology is based on USGS map standards and comes from the style file, "FGDC_CGS_20100414.style." Compiled measurements are distinguished from GMP field structural attitudes by the black symbol lacking a white halo. A definition query with a "yes" in the "Disp_Reg" attribute field selects the subset of measurements that can be displayed on Plate 1 without obscuring information due to overcrowding and, to a lesser degree, conceals potentially spurious measurements. The layer is labeled by the attribute field "dip."
- *Fault_Fold_Compilation_GMP*: Shows bedrock structural data (faults, lineaments, and fold axes). Data are from the integration of compiled map data and new information collected during GMP field mapping. The layer uses the line shapefile Fault_Fold_Compilation_GMP.shp. No transparency is used. The layer is symbolized on the "Type," "Certainty," and "Cartography" attribute fields. Symbology is based on USGS map standards and comes from the style file, "FGDC_CGS_20100414.style." A definition query of "Disp_Reg" = 'Yes' ensures that the subset of folds and faults intended for display on Plate 1 (at 1:32,000 scale) are shown. There are no labels associated with this layer. This layer includes a generalized depiction of the Los Osos fault zone and modifications to inferred traces of the San Luis Bay fault zone that are shown as thicker black lines.
- *Geology_Compilation_Contacts_GMP*: Shows geologic unit boundaries according to the compilation geologic map stratigraphy used on Plate 1. Geology unit polygons from the shapefile Geology_Compilation_GMP.shp were merged based on a 'compilation unit' attribute field in order to create the contacts

shapefile Geology_Compilation_Contacts_GMP.shp used by this layer. The layer does not distinguish between types of geologic unit boundaries (e.g., depositional contacts vs. fault contacts; well-located vs. approximately located). No transparency, special symbology, definition query, or label used (unit labels are displayed through an annotation geodatabase).

- *Coastline_from_CA_Coastal_LiDAR*: Shows the approximate low tide line as a white line. The layer uses the line shapefile Coastline_from_CA_Coastal_LiDAR.shp. No transparency, special symbology, definition query, or label used.
- *Geology_Compilation_GMP*: Shows colored geologic unit polygons compiled and updated for the GMP. The layer uses the polygon shapefile Geology_Compilation_GMP.shp. Transparency is set to 50% for Plate 1. The layer is symbolized using the “Comp_unit” attribute field. There are no definition queries or labels for this layer. Unit labels are displayed with an annotation geodatabase.
- *Locations and roads*: This group layer contains the following three layers:
- *Study_Area_Location_Names*: Shows the locations and names of prominent points along the coast on Plate 1. The layer uses the point shapefile Study_Area_Location_Names.shp. No transparency, special symbology, or definition query, used. Layer is labeled using the “NAME” attribute field.
- *City_Points*: Shows the locations and names of cities and communities on Plate 1. The layer uses the point shapefile City_Points.shp. No transparency or special symbology is used. A definition query is used to filter out some additional names in the shapefile that were considered unnecessary. Layer is labeled using the “NAME” attribute field.
- *Major_Highways*: Shows selected roadways on Plate 1. The layer uses the line shapefile Major_Highways.shp, provided by ESRI. No transparency or special symbology is used. A definition query on the attribute field “FID” is used to filter only essential roadways that are needed for map clarity. Layer is labeled using the “HWY_SYMBOL” attribute field.
- *Base maps*: This group layer contains the following two layers:
- *Contours_2013_07_UTM_NAD83_10m*: Shows topographic contours with 100 m contour intervals. The layer uses the geodatabase Contours_2013_07_UTM_NAD83_10m.gdb. The layer is turned off for Plate 1, but is included as an additional resource for the GMP or other PG&E-related projects. A definition query "Type" = '100s' is set for showing contours on the Plate 1 map or maps of similar scale. 10 m contours are also available in the geodatabase file.
- *Composite_HS_2013_07_UTM_NAD83_1m_315deg.jp2*: Shows a hillshade image from a composite onshore-offshore 1m DEM. The hillshade has an artificial sunlight azimuth of 315 degrees and an inclination of 45 degrees. A 50% transparency is used for Plate 1.

[End of layers for Plate 1]

## DCPP STUDY AREA (PLATE 2)

Map document file name: GMP_GIS_Package_Plate_2.mxd.

Brief descriptions of each layer included in the Plate 2 map document file are listed below.

Layers for the Inset:

- *Extent_of_Plates*: Shows the extent of Plates 1 and 2 on the Plate 2 inset map. Uses the polygon shapefile Extent_of_Plates.shp. No transparency, special symbology, definition query, or label used.
- *Index_map.tif*: Shows simple geography of the DCPP vicinity for geographic reference on the Plate 2 inset map. Uses Index_map.tif.

Layers for the Main Map:

- *Geology_Unit_Labels_3k*: This annotation geodatabase includes geologic map symbols and lead lines to accompany Plate 2. Uses geodatabase file "Geology_DCPP_Site_Anno_3k.gdb." No transparency, definition query, or label used.
- *GMP_FieldStations_All_GMP*: This layer is unselected for the Plate 2 display, but when selected will show locations of field stations recorded by GMP geologists. Layer source is Strike_Dip_Field_GMP.shp.
- *Strike_Dip_Field_GMP*: Shows bedrock structural measurements (bedding attitudes, local faults) collected during 2012 and 2013 GMP field mapping. The layer uses the point shapefile Strike_Dip_Field_GMP.shp. No transparency is used. The layer is symbolized on the attribute field "Type." Symbology is based on USGS map standards and comes from the style file, "FGDC_CGS_20100414.style." GMP field measurements are distinguished from previously-compiled structural attitudes by the white halo that outlines each attitude and associated label. A definition query with a "Yes" in the "Display" attribute field selects the subset of measurements that can be displayed on Plate 2 without obscuring information due to overcrowding. The layer is labeled by the attribute field "Dip_Plunge."
- *Strike_Dip_Compilation_GMP*: Shows bedrock structural measurements (bedding attitudes, local faults) compiled from existing data sets for the GMP. The layer uses the point shapefile Strike_Dip_Compilation_GMP.shp. No transparency is used. The layer is symbolized on the attribute field "Type." Symbology is based on USGS map standards and comes from the style file, "FGDC_CGS_20100414.style." Compiled measurements are distinguished from GMP field structural attitudes by the black symbol lacking a white halo. A definition query with a "yes" in the "Disp_Dtl" attribute field selects the subset of measurements that can be displayed on Plate 2 without obscuring information due to overcrowding and, to a lesser degree, conceal potentially spurious measurements. The layer is labeled by the attribute field "dip."
- *Fault_Fold_Compilation_GMP*: Shows bedrock structural data (faults, lineaments, and fold axes). Data are from the integration of compiled map data

and new information collected during GMP field mapping. The layer uses the line shapefile Fault_Fold_Compilation_GMP.shp. No transparency is used. The layer is symbolized on the “Type,” “Certainty,” and “Cartography” attribute fields. Symbology is based on USGS map standards and comes from the style file, “FGDC_CGS_20100414.style.” A definition query of "Disp_Dtl" = 'Yes' ensures that the subset of folds and faults intended for display on Plate 2 (at 1:3,000 scale) are shown. There are no labels associated with this layer.

- *DCPP_Site_Map_Contacts_GMP*: Shows unit contacts according to the DCPP geologic map stratigraphy used on Plate 2. Uses the line shapefile DCPP_Site_Map_Contacts_GMP.shp. No transparency is used. The layer is symbolized on the “Type,” “Certainty,” and “Cartography” attribute fields. Symbology is based on USGS map standards and comes from the style file, “FGDC_CGS_20100414.style.” No definition queries or labels are used.
- *Coastline_from_CA_Coastal_LiDAR*: Shows the approximate low tide line as a white line. The layer uses the line shapefile Coastline_from_CA_Coastal_LiDAR.shp. No transparency, special symbology, definition query, or label used.
- *Geology_Compilation_GMP*: Shows colored geologic unit polygons compiled and updated for the GMP within the DCPP study area. Uses the polygon shapefile Geology_Compilation_GMP.shp. Transparency is set to 50% for Plate 2. The layer is symbolized using the “Dtl_unit” attribute field. There are no definition queries or labels for this layer. Unit labels are displayed with an annotation geodatabase.
- *Geography*: This group layer contains the following two layers:
- *Roads*: Shows roads within the DCPP study area by TetraTech, Inc. (2010) based on lidar data. The roads have not been reviewed by DCPP for accuracy or completeness. Uses the line shapefile Roads.shp. No transparency, special symbology, definition query, or label used.
- *Buildings*: Shows buildings within the DCPP study area that were identified by TetraTech, Inc. (2010) based on interpretation of lidar data. The buildings have not been reviewed by DCPP for accuracy or completeness. Uses the polygon shapefile Buildings.shp. No transparency, special symbology, or label used. A definition query of "Area_sq_m" > 33 was used to remove very small structures from Plate 2.
- *Base maps*: this group layer contains the following two layers:
- *Contours_2013_07_UTM_NAD83_10m*: Shows topographic contours with 10 m contour intervals. The layer uses the geodatabase Contours_2013_07_UTM_NAD83_10m.gdb. The layer is turned off for Plate 2, but is included as an additional resource for the GMP or other PG&E-related projects. A definition query "Type" = '10s' is set for showing contours on the Plate 2 map or maps of similar scale. 100 m contours are also available in the geodatabase file.
- *Composite_HS_2013_07_UTM_NAD83_1m_315deg.jp2*: Shows a hillshade image from a composite onshore-offshore 1m DEM. The hillshade has an

artificial sunlight azimuth of 315 degrees and an inclination of 45 degrees. A 30% transparency is used for Plate 2.

[End of layers for Plate 2]

**PRICE CANYON STUDY AREA (FIGURE 3-9)**

Map document file name: Figure_03-9.mxd.

Brief descriptions of each layer included in the Figure 3-9 map document file are listed below.

Layers for the Inset:

- *DCPP_Site*: Shows the location of the DCPP site in the inset map. The layer uses the point shapefile DCPP_Site.shp. No transparency, special symbology, or definition query used. Label field is "Name."
- *Index_map.tif*: Shows simple geography of the DCPP vicinity for geographic reference on the Plate 1 inset map. Uses Index_map.tif.

Layers for the Main Map:

- *Wells_GMP*: Shows the location of oil and hydrogeologic wells considered for the GMP for geologic information and/or considered for seismic-reflection data processing for sonic log information. The layer uses the point shapefile Wells_GMP.shp. Layer symbology differentiates on "WELL_TYPE" attribute field between oil and gas wells (red) and hydrogeologic boreholes/well (blue). Layer is labeled based on "WELL_NAME" attribute field. No transparency or definition query used.
- *Figure 3-9 Geology*: This group layer file contains the following four layers:
- *Strike_Dip_Compilation_GMP*: Shows bedrock structural measurements (bedding attitudes, local faults) compiled from existing data sets for the GMP. The layer uses the point shapefile Strike_Dip_Compilation_GMP.shp. No transparency is used. The layer is symbolized on the attribute field "Type." Symbology is based on USGS map standards and comes from the style file, "FGDC_CGS_20100414.style." The layer is labeled by the attribute field "dip."
- *Fault_Fold_Compilation_GMP*: Shows bedrock structural data (faults, lineaments, and fold axes). Data for the Figure 3-9 study area are from compiled map data. The layer uses the line shapefile Fault_Fold_Compilation_GMP.shp. No transparency is used. The layer is symbolized on the "Type," "Certainty," and "Cartography" attribute fields. Symbology is based on USGS map standards and comes from the style file, "FGDC_CGS_20100414.style." There are no definition queries or labels associated with this layer as applied to Figure 3-9.
- *Geology_Compilation_Contacts_GMP*: Shows geologic unit boundaries according to the compilation geologic map stratigraphy used on Figure 3-9 and Plate 1. Geology unit polygons from the shapefile "Geology_Compilation_GMP.shp" were merged based on a 'compilation unit' attribute field in order to create the contacts shapefile

Geology_Compilation_Contacts_GMP.shp used by this layer. The layer does not distinguish between types of geologic unit boundaries (e.g., depositional contacts vs. fault contacts; well-located vs. approximately located). No transparency, special symbology, definition query, or label used (unit labels are displayed by converting labels to graphics).

- *Geology_Compilation_GMP*: Shows colored geologic unit polygons compiled and for the GMP. The layer uses the polygon shapefile Geology_Compilation_GMP.shp. Transparency is set to 50% for Figure 3-9. The layer is symbolized using the “Comp_unit” attribute field. There are no definition queries or labels for this layer. Unit labels are displayed by converting labels to graphics.
- *Geography*: This group layer contains the following one layer:
- *City_Points*: Shows the locations and names of cities and communities on Figure 3-9. The layer uses the point shapefile City_Points.shp. No transparency or special symbology is used. A definition query is used to show the town of Edna on Figure 3-9. Layer is labeled using the “NAME” attribute field.
- *Base maps*: This group layer contains the following two layers:
- *Contours_2013_07_UTM_NAD83_10m*: Shows topographic contours with 10 m contour intervals. The layer uses the geodatabase Contours_2013_07_UTM_NAD83_10m.gdb. The layer is turned off for Figure 3-9, but is included as an additional resource for the GMP or other PG&E-related projects. A definition query "Type" = '10s' is set for showing contours on maps of similar scale. 100 m contours are also available in the geodatabase file.
- *Composite_HS_2013_07_UTM_NAD83_1m_315deg.jp2*: Shows a hillshade image from a composite onshore-offshore 1m DEM. The hillshade has an artificial sunlight azimuth of 315 degrees and an inclination of 45 degrees. A 50% transparency is used for Figure 3-9.

[End of layers for Figure 3-9]

# Appendix E: Stratigraphic and Geophysical Data from Historical Wells in the Irish Hills and Vicinity

## ABSTRACT

Records of historical oil and hydrogeologic wells provide geologic and geophysical data for understanding the subsurface stratigraphy, structure, and material properties near the Diablo Canyon Power Plant (DCPP), San Luis Obispo County, California. Records for 26 oil and gas wells and 8 hydrogeologic wells are reviewed and summarized in this data report. The oil wells were drilled between 1928 and 2008 to depths of approximately 1,000 to 10,800 feet, and most records are on file at the Santa Maria office of the California Division of Oil, Gas, and Geothermal Resources. Additional paleontological information for the oil wells was obtained from the core repository at California State University, Bakersfield. Typical records available included a well summary report, driller's log, lithologic log, paleontology report, electric log, sonic log, and dip log. Not all record types are available for every well. Sonic log data, available for 8 of the wells, were digitized to help establish the P-wave velocities of the various lithologic units at depth. The hydrogeologic wells are located in the Los Osos–Baywood Park area adjacent to Morro Bay and range in depth from approximately 500 to 750 feet. Well logs were obtained from a groundwater report prepared by Cleath & Associates in 2003. Typical information available for the wells includes geologic and electronic logs.

# TABLE OF CONTENTS

**Page**

## ADDITIONAL SECTIONS (in Separate Electronic Files)

## LIST OF TABLES



## LIST OF FIGURES



## LIST OF PLATES

# Appendix E: Stratigraphic and Geophysical Data from Historical Wells in the Irish Hills and Vicinity

## E1.0 INTRODUCTION

Historical well data provide information on the subsurface stratigraphy and geophysical properties of rock units in the vicinity of the Diablo Canyon Power Plant (DCPP). This data report documents the review of existing well data in the Irish Hills area (Figure E1-1), where seismic-reflection survey data were collected in 2011 by Pacific Gas & Electric Company (PG&E).

Hundreds of wells have been drilled in San Luis Obispo County for oil and gas exploration. These wells, dating from as early as the 1920s and continuing to present day, are a valuable source of information on the subsurface strata. Only a handful of prospecting wells were drilled in the Irish Hills near DCPP and near the main area of seismic-reflection surveying. All were "dry" holes, drilled between 1927 and 1958, and focused on Tertiary rocks of the Pismo Basin. The closest producing oil field within the Pismo Basin is the Arroyo Grande Field located at the eastern margin of the Irish Hills, in the Price Canyon area. While the DCPP site is some distance from this field and others, many of the DCPP stratigraphic units can be traced continuously to, or have lithologic analogs in, the producing oil fields. Therefore, key wells from the oil fields and other locations farther from the seismic-reflection survey area, including three offshore wells, are reviewed in this report.

In addition to the oil wells, which have typical depths of several thousand feet and are up to over ten thousand feet deep, shallower hydrogeologic wells drilled for groundwater monitoring and/or supply provide useful geologic information for the interpretation of seismic-reflection data. Several relatively deep (several hundred feet to approximately 750 feet deep) hydrogeologic wells are located in the Los Osos groundwater basin that includes the low-lying areas adjacent to Morro Bay. Eight wells located in the direct vicinity of seismic-reflection profile lines collected by PG&E in 2011 provide geologic data constrains for the project and are included in this report.

This well data report was prepared for the Geologic Mapping Project by Dr. Janet Sowers of Fugro Consultants, Inc. (FCL), with contributions from Dr. Stephen Thompson and Mr. Brian Gray of Lettis Consultants International, Inc. (LCI).

## E2.0 METHODS

The approach of this study was to collect, plot, and analyze geologic and geophysical well log data relevant to the recently completed seismic-reflection surveys. Tasks included data collection, interpretation of stratigraphy, assessment of well location and elevation accuracy and uncertainty, construction of a deviation log (for the Honolulu-Tidewater 1 well only), and the digitization of sonic log data. These methods are described in Sections E2.1 to E2.5 below.

### E2.1 Data Collection

Both onshore and offshore well data were collected. Wells were selected for study on the basis of their proximity to the Irish Hills seismic-reflection survey area and the availability of

stratigraphic information and/or sonic log data (Figure E1-1). All oil well records are compiled and provided separately in electronic format in (electronic) Section E6.0.

Onshore oil well information is summarized in a database maintained by the California Department of Oil, Gas, and Geothermal Resources (DOGGR), based on records collected for each oil well as required by the state. The well database is available online at http://maps.conservation.ca.gov/doms/doms-app.html. These summary well data, in Excel and ArcGIS shapefile format (February 2011 update), were downloaded and used as a primary source of information. The DOGGR records typically include detailed well history, core records, lithologic logs, and geophysical logs. Scans of these files were obtained for each well from either the DOGGR or the U.S. Geological Survey (USGS). The USGS had collected a number of detailed well records for internal research purposes (e.g., Sweetkind et al., 2010) and provided these records to PG&E by CD (V. Langenheim, USGS, pers. comm., 2010).

Additional data for onshore oil wells were obtained by various means. A commercial service operated by TGS-NOPEC called LOG-LINE Plus! provides for purchase printed copies of well logs they have collected. We obtained sonic logs for five onshore wells from this service by ordering them from the website at http://www.tgsnopec.com/data.aspx. Additional records for the Honolulu-Tidewater 1 well, not included in the DOGGR or USGS files, were provided by Chevron-Texaco (L. Knauer, Chevron, pers. comm., 2013). Paleontology reports accompanying some of the wells (Maino-Gonzales 1, Pecho 1, and Spooner 1) were purchased online from the California Well Sample Repository collection at California State University, Bakersfield (CSUB).

Of particular note is the unsuccessful search for sonic log data for the Honolulu-Tidewater 1 well. The history file for that well indicates sonic logs were collected for the lower portion of the well. However, no logs were found through our search with the DOGGR, the commercial LOG-LINE Plus! service, with the CSUB Well Repository, or with the current owner of the well (Chevron-Texaco).

Offshore well data were obtained from published literature primarily. Logs of offshore wells in the vicinity of the DCPP were provided in Willingham et al. (2013, Plate 3) and Hall (1982). Three offshore wells were selected for study, primarily to provide P-wave velocity information on the offshore units. Information for Oceano well P-060-1 was obtained from Hall (1982), McCullough (1987), and Miller and Meltzer (1999). Additional information on the offshore wells, including API numbers, measured depths, and well owner information, was taken from the database maintained by the federal Bureau of Ocean Energy Management (BOEM), which was downloaded in ArcGIS shapefile format (May 29, 2012, update; file “Pacific Wells.zip” downloaded 7/24/2013 from www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Pacific.aspx).

Information from hydrogeologic wells in the Los Osos–Baywood Park area adjacent to Morro Bay was evaluated and compiled from a 2003 report by Cleath & Associates, “Geologic Structure of the Los Osos Valley Ground Water Basin” that was provided to PG&E by Tim Cleath of Cleath-Harris Geologists, Inc. (personal communication, 2011). The main report and appendix materials include maps of well locations, well summary information, geologic logs, and scans of electronic logs (referred to herein as “e-logs”). Information provided for a few

of the wells was incomplete (e.g., there is no indication of the year drilled for wells 30S/11E-17E7 or 30S/11E-18K8).

Available data were collected, compiled, and analyzed for 26 historical oil wells and 8 hydrogeologic wells. Table E2-1 lists the oil wells by API. Table E2-2 lists the hydrogeologic wells by the California state well number per Cleath & Associates (2003). Of the 34 well records selected, 18 are located on or adjacent to seismic-reflection profile lines collected in 2011, and 8 include sonic log data (including 3 offshore oil wells) (Tables E2-1 and E2-2). The locations of the 34 wells are shown on Figures E1-1, E2-1, and E2-2. Those with sonic logs are shown in yellow. Figures E2-1 and E2-2 also show the locations of the 2011 seismic survey lines.

**Table E2-1. Historical Oil Wells Selected for Study**

| # | API Number | Name | Adjacent to Seismic Line? | Sonic Log? | Total depth (feet) |
|---|---|---|---|---|---|
| 1 | 079-00174 | See Canyon 1 | No | No | 2,545 |
| 2 | 079-00247* | Maino-Gonzales 1 | Yes | No | 1,575 |
| 3 | 079-00310* | Pecho 1 | Yes | No | 2,745 |
| 4 | 079-00378 | Mello 2 | Yes | No | 1,505 |
| 5 | 079-00380* | Spooner 1 | Yes | No | 1,749 |
| 6 | 079-00471 | Bassi Core Hole 1 | No | No | 959 |
| 7 | 079-00477* | Honolulu-Tidewater 1 | Yes | No | 10,788 |
| 8 | 079-00478* | Montadoro 1 | Yes | No | 6,146 |
| 9 | 079-00486 | Heller Core Hole 1 | No | No | 1,305 |
| 10 | 079-00550 | Townsend-Gunter 1 | No | No | 3,286 |
| 11 | 079-00551 | Townsend-Peterson 1 | No | No | 1,445 |
| 12 | 079-00581 | Sousa 1 | Yes | No | 1,233 |
| 13 | 079-00591 | Signal ETS 1 | Yes | No | 1,168 |
| 14 | 079-00618 | Rock 75 | Yes | No | 2,200 |
| 15 | 079-00654 | Holmes 1 | No | No | 3,935 |
| 16 | 079-00671 | Tar Springs 1A | No | Yes | 3,744 |
| 17 | 079-20532 | Leroy F-7B | No | Yes | 7,310 |
| 18 | 079-20544 | Guidetti A1 | No | No | 3,050 |
| 19 | 079-20545 | Guidetti A3 | No | Yes | 3,050 |
| 20 | 079-20547 | Guidetti A7 | No | No | 2,751 |
| 21 | 079-20566 | Guidetti A4 | No | Yes | 3,000 |
| 22 | 079-20594 | Shell Beach 1 | No | Yes | 5,547 |
| 23 | 079-21166 | Rock 11G | Yes | Yes | 2,005 |

| # | API Number | Name | Adjacent to Seismic Line? | Sonic Log? | Total depth (feet) |
|---|---|---|---|---|---|
| 24 | 560452001300 | P-0435-1 | No | Yes | 6,900 |
| 25 | 560462000100 | P-060-1, Oceano 1 | No | No | 8,020 |
| 26 | 560462000500 | P-0397-1 | No | Yes | 3,666 |

* Well log details presented on Plates E1 through E5.

**Table E2-2. Historical Hydrogeologic Wells Selected for Study**

| # | State Well Number[1] | Name | Adjacent to Seismic Line? | Sonic Log? | Total depth (feet) |
|---|---|---|---|---|---|
| 1 | 30S/10E-13L4 | CCW Pecho | Yes | No | 675 |
| 2 | 30S/10E-13Na | S&T New | Yes | No | 500 |
| 3 | 30S/11E-17E7 | LOCSD—SB deep | Yes | No | 560 |
| 4 | 30S/11E-17N10 | CCW—SB#1 | Yes | No | 750 |
| 5 | 30S/11E-18F2 | LOCSD—Ferrell #2 | Yes | No | 645 |
| 6 | 30S/11E-18K8 | LOCSD—10th New | Yes | No | 650 |
| 7 | 30S/11E-18L2 | LOCSD—Palisades | Yes | No | 612 |
| 8 | 30S/11E-18L6 | USGS—Palisades | Yes | No | 620 |

[1] From Cleath & Associates (2003).

Five historical oil wells drilled in the Irish Hills in close proximity to the 2011 seismic reflection lines (Figure E2-1) are of special interest. Available well log data for these five wells were assembled on oversized plates (Plates E1 through E5) to better understand the nature and quality of the data and interpretations in these locations. Each plate shows, plotted side-by-side versus depth, all log data available for the well, which may include a lithologic log, e-log, dip log, paleontological information, and various stratigraphic interpretations. These five wells were drilled from 1927 to 1958. Data for these wells are of varying quality and completeness, and lack some information contained in modern geologic and geophysical logging. No sonic logs were encountered for these wells.

## E2.2 Evaluation of Well Location, Elevation, and Location Accuracy and Uncertainty

Available well location and elevation information was evaluated to improve accuracy where possible and to estimate the uncertainty in these data for each well. For onshore oil wells, location and elevation information is listed in the DOGGR database, which is primarily based on the locations described in the well records. According to Ross Brunetti, DOGGR

geologist/petroleum engineer in Orcutt, California), the well locations in the DOGGR database were digitized from points that had been hand-plotted using the location information in the well record on a map at a scale of 1 inch = 1 mile (R. Brunetti, pers. comm., 2013). Given this method, the points in the database are expected to be approximate locations only, and location information provided in the original well record should be considered more precise than the digitized points created by DOGGR. Most well records report location with respect to the Public Lands Survey (PLS) system.

The onshore oil well locations discussed in this report and provided in ArcGIS shapefile format in electronic Section E7.0 were compiled by the following methods:

- Observation in the field by GMP geologists at two onshore oil wells (Spooner 1 and Honolulu-Tidewater 1).
- Study of the onshore oil well history records and plotting of PLS locations in ArcGIS based on information provided in the well records.
- Acceptance of the locations provided in the DOGGR database (most typical for wells not located directly on or adjacent to seismic-reflection lines).
- Consideration of well locations marked on USGS topographic sheets and on geologic maps (e.g., Hall, 1973a).

Initial locations of the offshore wells were taken from digitized figures and plates in Willingham et al. (2013). Revised and reported locations of the offshore wells, along with API numbers, measured depths, and well owner information, were taken from the BOEM database ArcGIS shapefile). As the well names reported in Willingham et al. (2013) and other literature were not present in the BOEM database, the correct wells were identified based on the approximate location and well depth.

The hydrogeologic well locations are digitized from Figures 1 and 2 in Cleath & Associates (2003).

Onshore well elevations are provided in the DOGGR database and commonly in the well history files. Well elevations are also estimated based on the well locations and an onshore-offshore digital elevation model (DEM) compiled for the DCPP region by PG&E. Within the Irish Hills study area, this DEM is mostly based on on-land LiDAR surveys flown for PG&E in 2010 and 2011 and multibeam bathymetric surveys acquired by the state of California and PG&E for the continental shelf. Outside the area of LiDAR coverage, on-land data are derived from the regional 30-meter (m) elevation data provided by the U.S. Geological Survey. In the offshore areas beyond the multibeam survey, the study region DEM is based on a southern California bathymetry data set.

The best-estimate ground surface elevations for the wells provided in the GIS shapefile (see electronic Section E7.0) are based on the DEM-derived elevations corresponding to the best-estimate well coordinates. The best-estimate top-of-well elevations provided in the GIS shapefile are based on the ground surface elevation plus an offset that represents the distance between the ground surface and the zero depth point for the well log (commonly at the Kelly bushing, or KB). Offsets between the ground surface and the top of the well log are either provided in the well history file or are estimated. If no offset was encountered in the history file, a default offset

of 5 feet was assumed for the onshore oil wells, and a zero offset was assumed for offshore oil wells and hydrogeologic wells.

Accuracy of the well locations and elevations varies considerably. For the key wells located adjacent to seismic-reflection lines, the location accuracy and uncertainty is discussed in Section E3.

## E2.3 Interpretation of Stratigraphy

Geologic information was reviewed for each well and stratigraphic interpretations were made based on the available data. Lithologic and stratigraphic information typically were recorded in the field by geologists who described the material (cuttings, core, or sidewall core samples), as drilling proceeded. The descriptions are recorded on either a mud log, core log, or lithologic log. The geologist may or may not have written down an interpretation of formation contacts. If formation contacts were not written on the original logs, we interpreted the formation contacts based on the lithologic and geophysical properties of the rock, and our stratigraphic understanding. This understanding is based primarily on the geologic mapping and stratigraphic descriptions of Hall (1973a, 1973b), William Lettis & Associates, Inc. (WLA, 2001), several papers published in the U.S. Geological Survey Bulletin 1995 series (e.g., Keller et al., 1996; Schneider and Fisher, 1996; Schwalbach and Bohacs, 1996; Cole and Stanley, 1998), and work performed for the GMP (i.e., this study). Discussion of the stratigraphic interpretation is included in the descriptions for each individual well presented in Section E3.

It is important to note the evolution of the stratigraphic framework for the Pismo Basin when evaluating stratigraphic calls by well geologists. Mapping in the Pismo Basin by Hall (1973a, 1973b) established a Neogene stratigraphic sequence that differentiated middle to upper Miocene Monterey Formation from upper Miocene to Pliocene Pismo Formation based on a recognized unconformity and interfingering in the lower Pismo Formation between a deep-water facies (Miguelito Member) and a shallower water facies (Edna Member). The geologic map produced for the GMP follows the stratigraphic framework of Hall (1973a, 1973b). Prior to Hall's mapping, which includes the time period of all onshore oil wells drilled in the Irish Hills area, the deep-water Miguelito Member was mapped as Monterey Formation because they are lithologically similar. Regional stratigraphic frameworks continue to group the lower Pismo Formation within the "upper Monterey Formation" (e.g., Dibblee, 2004, 2006a, 2006b, 2006c). Thus, formation calls of "Monterey Formation" by geologists in the well records are considered candidates for the Monterey Formation or the Miguelito Member of the Pismo Formation for this study.

Previous workers have made stratigraphic interpretations of these wells, and a comparison of these interpretations shows there is considerable uncertainty in the formations encountered in the wells and locations of the formation contacts. A compilation of approximately 300 well logs and an interpretation of the subsurface stratigraphy were published by Hall (1982). The publication includes a tabulation of the depths of stratigraphic contacts in these wells, as well as subcrop and structure contour maps of the pre-Miocene basement surface. The stratigraphic contacts are based on Hall's interpretation of the available well log data and understanding of the geologic structure. Nine of the wells interpreted by Hall (1982) are also interpreted here. Clarification of the stratigraphic interpretation for four of the wells was requested from Clarence Hall of the

University of California, Los Angeles, who responded in a letter transmitted via e-mail dated August 9, 2011 (see electronic Section E8.1).

Sweetkind et al. (2010) published a digital compilation of approximately 600 wells in the Santa Maria Basin area. Fourteen of these are among the wells compiled here. They tabulate the depth in feet of the top of major stratigraphic units encountered in each well.

Telephone interviews and e-mail exchanges were conducted with Ross Brunetti of the DOGGR and Kristin McDougall of the U.S. Geological Survey, to help improve the technical basis for the stratigraphic interpretations (see electronic Section E8.0). Mr. Brunetti is a geologist with many years of experience interacting with the oil and gas industry in San Luis Obispo County. His interpretations and reasoning based on recent phone conversations (see electronic Section E8.2), are incorporated into the well descriptions in Section E3 and on Plates E1 through E5. Dr. McDougall is a paleontologist with expertise in the biostratigraphy of Tertiary formations in coastal California. She provided information that helped with the interpretation of the paleontological data and is incorporated into the interpretation of well stratigraphy. See electronic Section E8.3 for interview notes.

The preferred and alternative stratigraphic interpretations for each well are presented in Section E3. Where differences exist between previous stratigraphic interpretations and this report, a discussion is provided.

## E2.4 Construction of a Deviation Log (Honolulu-Tidewater 1 Well Only)

A deviation log provides a record of the change in inclination (deviation from vertical) of a well with depth. Drift of the well hole from vertical is common in drilling even when not intended due to rock heterogeneities. Among the key wells that are located along or adjacent to seismic-reflection profiles, only the Honolulu-Tidewater 1 well had records from which a deviation log could be constructed. None of the key wells along or adjacent to seismic-reflection profiles had summary tables of well hole drift included within the well history reports.

Records of borehole azimuth and inclination for the Honolulu-Tidewater 1 well were recorded on a dipmeter log obtained by Chevron-Texaco (L. Knauer, Chevron, pers. comm.; see electronic Section E6.0). For each dip entry on the dipmeter log there are reported drift azimuth (in degrees) and drift angle (in degrees-minutes). From these records, we constructed a log of downhole drift with columns for hole easting, northing, and elevation in Excel.

Plots of depth (in feet) versus drift azimuth (in degrees), depth (in feet) versus drift angle (in degrees), and depth (in feet) versus east and north drift (in feet) are presented on Figure E2-8. The Excel file is included in electronic Section E9.0.

The result suggests that, from the top of the well to the bottom, the hole had a net drift of approximately 220 feet (67 m) east, 219 feet (67 m) south, and a change in elevation of 10,765 feet from the top of the hole to the bottom (as compared to the 10,788 feet downhole depth). The largest angular deviation from vertical was 9.5 degrees, with this type of deviation to the south-southeast (approximately 160 deg. azimuth) at depths between approximately 6,500 feet and 8,000 feet (Figure E2-8).

This information may be useful for estimating location uncertainties due to well drift for wells with no deviation information. To help with this, Table E2-3 below is an array that shows the horizontal distance change from the bottom of a hole to the top of a hole given hole depths ranging from 500 to 12,000 feet, and with average drift angles of 2, 5, and 10 degrees.

**Table E2-3. Matrix of Scenario Well Deviations (in feet) for Consideration in Well Location Uncertainty Estimates**

| Horizontal Change in Location (in ft.) from Top to Bottom of Hole | | Average Drift Angle (degrees) | | |
|---|---|---|---|---|
| | | 2 | 5 | 10 |
| Hole Depth (ft.) | 500 | 17 | 44 | 87 |
| | 1,000 | 35 | 87 | 174 |
| | 2,000 | 70 | 174 | 347 |
| | 4,000 | 140 | 349 | 695 |
| | 8,000 | 279 | 697 | 1,389 |
| | 12,000 | 419 | 1,046 | 2,084 |

## E2.5 Digitization of the Sonic Log Data

A *sonic log* is a type of acoustic log that displays travel time of P-waves through a short interval of rock in the well bore, versus depth. Sonic logs are typically recorded by pulling a tool on a wireline up the wellbore. The tool emits a sound wave that travels from the source to the formation and back to a receiver. The travel time of the sound wave is a function of the lithology and the density of the formation.

Sonic logging was done in a relatively small percentage of the wells drilled in the area. The continuous downhole method, invented in 1951 (Close et al., 2009), was not widely used in the San Luis Obispo area until the 1960s. Even then, while almost all wells have an e-log, only some have a sonic log.

The sonic log data consist of plots of travel time versus depth recorded by the downhole instrumentation. All were in paper format, variable in scale and quality of the reproduction. To compare the sonic log data and perform quantitative analyses, the logs were first digitized.

The digitization procedure used a combination of ArcGIS and Excel software to create a table of Vp versus depth. First, the paper logs were scanned and brought into GIS as images. Each image was then placed in an artificial geographic space, and georectified as if both axes of the logs were length in feet. In actuality, only the y-axis is in feet, and the x-axis is interval transit time, T, in seconds. The travel time curve was then digitized by setting points along the line with a sufficient density to define the curve. Emphasis was placed on setting the points at inflection points and changes in direction of the curve.

The coordinates of the points that define the curve were then exported to Excel. To calculate a Vp profile, the length units that had been used for the x-axis were converted to interval transit

time. Then interval transit time (T) was converted to P-wave velocity (Vp) by the following equation:

Vp (feet per second) = 1,000,000/T

A new plot was then created of Vp versus depth for each well. These plots are presented for 8 wells in Figures E2-9 through E2-12. The Excel files are provided in electronic format in electronic Section E10.0.

# E3.0 WELL DATA SUMMARIES AND INTERPRETATION

Data for each of the 26 oil wells and 8 hydrogeologic wells chosen for study are presented below, in order by API number (for oil wells), then hydrogeologic well number assigned by Cleath & Associates (2003). Tables E2-1 and E-2-2 thus may be used as an ordered listing of wells described below. Summary information includes whether the well is located on or adjacent to the 2011 seismic-reflection survey, year drilled, total depth, elevation, source of data, and available data. Additional information includes a location description, stratigraphic summary table with estimated formation top elevation, and discussion of stratigraphy.

Formation names in some cases are provided by the geologist logging the core and may have been written on the original logs or well summary sheet, although we note that "Monterey" may be consistent with either Monterey Formation or Miguelito Member, Pismo Formation in the project stratigraphic framework (Section E2.3). Formation names in all other wells were interpreted based on the lithologic descriptions, the geophysical logs, paleontological information, and existing geologic mapping. The abbreviation "BOH" in the depth columns of the tables indicates the bottom of the hole, and "ND" in any column indicates "no data available."

Graphic log data for 5 wells in the Irish Hills are compiled and presented on Plates E1 through E5.

## E3.1 API 07900174, Old See Canyon 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1928 and 1937

TOTAL DEPTH: 2,545 ft. (776 m)

ELEVATION, TOP OF WELL: Approx. 937 ft. (286 m)

SOURCE OF DATA: DOGGR files, Hall (1982; pers.comm., 2011)

AVAILABLE DATA: History file, including lithologic log and geologist's report

LOCATION: The location of this well is uncertain. The location provided by the DOGGR database puts the well at an elevation of more than 900 feet, in conflict with the reported elevation of 680 feet. Plotting the location in ArcGIS using the PLS grid and location information from the history file puts the well within 100 feet of the DOGGR location, again at an elevation above 900 feet. Either of these locations is near the Monterey Formation/Obispo Formation contact, which, according to mapping by Hall (1973a) dips to the southwest. The well, therefore, should

penetrate only a short section of Monterey Formation before entering the Obispo Formation. Instead, the well log suggests it penetrates at least 694 feet (base of flint) of Monterey Formation.

We considered whether the reported elevation might help locate the well. If the well is moved north to an elevation of 680 feet, it falls into an area mapped as Obispo Formation. Moving it south to lower elevations puts it into an area mapped as the Edna Member of the Pismo Formation. Here the well would have eventually penetrated Monterey Formation, but should have logged sandstone (Edna Member) over Monterey tuffaceous shale (Tmmts), first, which it does not. No reasonable location was consistent with both the reported elevation and the lithology reported in the well log.

Aerial photography, taken in 1939, two years after completion of the well, was examined for signs of roads and a well pad. No evidence was found in the vicinity of the plotted location, or anywhere within 2,000 feet of that location. Therefore, the location of the See Canyon well remains uncertain. We estimate that the true location does indeed lie within 2,000 feet of the location provided by DOGGR and the well record, and is most likely to be west or south of that location.

Using the location from the DOGGR database, we estimate a ground elevation of the well at approximately 932 feet, based on the LiDAR-based project DEM. Assuming a 5-foot offset between the ground surface and the top of the well (corresponding to zero depth on the logs), we estimate the elevation of the top of the well to be 937 feet. Based on the uncertainty in the location noted above, this elevation may have several hundred feet of uncertainty.

STRATIGRAPHY: According to the GMP geologic map, the well spudded in Monterey Formation. The deepest unit encountered is described as a breccia with fragments of a variety of rock types. Consulting geologist George Wilbur examined the cores in 1937 and interpreted the breccia as a fault zone. His letter describing the core and explaining this interpretation is in the history file (see electronic Section E6.0). Hall (1982), however, interprets this unit as Franciscan Complex, an interpretation that appears to be inconsistent with the description of the core. Sweetkind et al. (2010) adopt the Hall (1982) interpretation.

Dr. Hall explained in an August 2011 letter (see electronic Section E8.1) that the well should have encountered the Franciscan Complex above 2,275 feet based on a 900-foot maximum thickness of the Tertiary units in the area:

> The well spudded into the basal Monterey Formation (Tmmb, blocky dolomitic shale), whose maximum thickness in the area is approximately 200 feet. Stratigraphically beneath the Tmmb is the Obispo Formation (Tmo), with a maximum thickness in the immediate area of the well of approximately 500 feet. Beneath the Tmo is the Rincon Shale (Tmr) with a maximum thickness of approximately 100 feet in this area. Stratigraphically beneath the Tmr is the Vaqueros Formation (Tov), with a thickness that does not exceed 100 feet. Thus, the Tertiary section or the Tm of the well log could not be more than 900 feet thick and the top of the Franciscan Complex must be above the 2,275 feet of the well log.

Accounting for a dip of bedding of 65 to 70 degrees and assuming all Tertiary units are present in the expected thicknesses given by Hall, the top of the Franciscan Complex should have been

encountered at 2,130 to 2,631 feet. Franciscan material was indeed encountered in the breccias at 2,275 to 2,545 feet.

The main conflict, therefore, between Hall's interpretation and Wilbur's interpretation may be the identification of the material as in-place Franciscan Complex as opposed to fault breccia. This difference in interpretation is significant in the potential to use the presence of the fault breccia in this well as subsurface evidence for the Edna fault. A summary of the well interpretation, including a qualitative confidence assessment in the formation interpretations, is presented in Table E3-1.

**Table E3-1. Summary Interpretation of the Old See Canyon 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 2,275 | Undifferentiated Monterey, Obispo, Rincon, and Vaqueros Formations | Blue and gray shale. Flint interbeds between 520 ft. and 698 ft. Includes beds of gray sand, shells, and conglomerate below 698 ft. | High |
| 2,275 to 2,545 BOH | Franciscan Complex and/or possible fault zone (Edna fault?) | Breccia with fragments of rhyolite tuff, serpentinite, Monterey shale, gray sand, intrusive diabase. | Low |

## E3.2 API 07900247, Maino-Gonzales 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1937

TOTAL DEPTH: 1,575 ft. (480 m)

ELEVATION, TOP OF WELL: Approx. 317 ft. (97 m)

SOURCES OF DATA: DOGGR files, Hall (1982), Brunetti (pers. comm., 2013), CSUB Well Repository

AVAILABLE DATA: History file, including well summary record; brief lithologic log; report of abandonment; handwritten depths of formation contacts; paleontology report by C. Canfield of Union Oil Company of California (1937)

LOCATION: The well history file reports the location of the Maino-Gonzales 1 well at 550 feet north and 330 feet east from the southwest corner of Section 24, T30S-R10E, and at an elevation of 310 feet measured from the derrick floor. Plotting this location in ArcGIS shows it to be approximately 70 feet northeast of the location in the DOGGR database, with both locations in the floor of Hazard Canyon (Figure E2-3). The PLS-based location corresponds to a LiDAR-based elevation of 312 feet. Assuming the derrick floor is approximately 5 feet above the ground, the top of the well (at the derrick floor) is at approximately 317 feet elevation. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±20 feet (6 m).

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Section E2.4 presents results for the Honolulu-

Tidewater 1 well, the only well in the Irish Hills study area that has deviation information. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift angles. For the Maino-Gonzales 1 well, which is approximately 1,600 feet deep, Table E2-3 suggests an additional ±140 feet uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: According to the GMP geologic map and the mapping of Hall (1973a), the well spudded in alluvium of Hazard Canyon that directly overlies the Miguelito Member of the Pismo Formation. The well records from 1937 state that the Monterey Formation extends to 1,564 feet where serpentine Franciscan Formation was encountered. Drilling of the serpentine continued to 1,575 feet, the total depth of the hole. The Log and Core Record describes the lithology above 1,564 feet as primarily shale with some sand intervals. As described in Section E2.3, the interpretation of the strata as Monterey Formation at the time of drilling in 1937 pre-dates the stratigraphic scheme of Hall (1973a) that defined the distinct Pismo Formation as separate from the Monterey Formation based on a locally recognized unconformity. The Miguelito Member is generally lithologically similar to the Monterey Formation.

The paleontology report provides detailed lithologic descriptions and includes a column recording foraminifer species along with radiolarians and sponge spicules. The report notes that pyrite was encountered at a depth of approximately 960 feet, and extended to the top of the serpentine. Paleontologist Charles Canfield of Union Oil Company of California did not identify any additional formation contacts in the well in 1937, and simply states, “The top of the Franciscan in Gretna Oil Co. Gonzales #1 is 1,564 feet.” We presume that the fauna he noted were consistent with those known from the Monterey Formation at that time.

The geologic map and well information were evaluated to determine if the basal contact of the Miguelito Member of the Pismo Formation could be identified above the contact with Franciscan Complex serpentinite, and what Tertiary stratigraphic units below the Miguelito Member may be present. The GMP geologic map shows the Maino-Gonzales 1 well to be located directly adjacent to the axial trace of a northwest-trending anticline (Plate 1 of the main GMP report). Approximately 2 km southeast of the well along the axial trace, the geologic map shows a breach of the anticline and an exposed sequence of, in descending order, Edna Member (Pismo Formation), Rincon Formation, Vaqueros Formation, and Franciscan Complex serpentinite. In the breach, a tapering sliver of Obispo Formation is mapped on the southwest limb of the anticline. These map relations suggest that an erosional event prior to or during deposition of the Pismo Formation eroded out the Monterey Formation and Obispo Formation along this portion of the northeast limb of the Pismo syncline. Approximately 2 km due east of the Maino-Gonzales 1 well, a sliver of serpentinite is mapped directly underlying Miguelito Member of the Pismo Formation adjacent to the core of another anticline (Plate 1 of the main GMP report), suggesting the erosional event may locally have cut out the lower Tertiary units as well.

Approximately 5 km south-southwest of the Maino-Gonzales 1 well, on the opposite limb of the Pismo syncline near Point Buchon, the Miguelito Member of the Pismo Formation is mapped overlying the Monterey Formation (Hall, 1973a; Plate 1 of main report). There, the contact appears gradational near or directly southwest of Coon Creek. Based on work by Keller and

Barron (1993) and cited by Schwalbach and Bohacs (1996), diatom and silicoflagellate assemblages indicate a late Miocene (9 to 10.4 million years ago [Ma]) age of the base of the Miguelito Member at the Coon Creek site. This contrasting stratigraphic relationship suggests that the Pismo Basin may have had considerable relief during the late Miocene, or that proximal and/or rapid faces changes in the Monterey and/or Pismo Formation have led to erroneous mapping.

Thus, on the basis of geologic map evaluation, the prediction for the Maino-Gonzales well would be that it penetrates the Miguelito Member of the Pismo Formation, then possibly the Edna Member, Rincon Formation, Vaqueros Sandstone, and serpentinite similar to the sequence seen in the breached anticline to the southeast. Alternatively, it is possible that Monterey Formation is present in the well below the Pismo Formation if the structural and stratigraphic relations beneath the well are more similar to those of the southwest limb of the Pismo Syncline near Coon Creek/Point Buchon.

Lithologic descriptions suggest that the top of the Monterey Formation, if present, may be present as shallow as the upper 100 feet of the well. The log shows gray siltstone and brown shale with streaks of calcite from 100 to 125 feet, becoming cherty at 150 feet. Most intervals below 150 feet are described as "cherty." Although opaline chert and porcelaneous shale are present in the Miguelito Member locally, these facies tend to be less common in the Miguelito Member as compared to the Monterey Formation. An increase in chert is noted at 381 feet, along with notations of radiolarians and spicules. Therefore, the top of the Monterey Formation could tentatively be placed as shallow as 100 feet, the beginning of detailed logging of siltstone and shale, or perhaps as shallow as 381 feet, corresponding to the noted increase in chert.

A specimen of the foraminifer *B. marginata* is noted at 504 feet. The specimen may be *Bolivina marginata*, a lower Luisian to lower Mohnian species. Kleinpell (1938) notes the occurrence of this species in both the Monterey Formation and the Rincon Shale, but in the later stratigraphic framework of Hall (1973a), the species may be consistent with the basal part of the Miguelito Member in accordance with the findings at Point Buchon (Keller and Barron, 1993). Alternatively, *B. marginata* may be *Bulimina marginata*, a Repettian or younger species of probable Pliocene age that may be consistent with the upper part of the Miguelito Member.

Miguelito Member or Monterey Formation likely continues to at least a depth of 1,047 feet, the lowest depth for which chert is reported. From 1,047 to 1,486 feet, lithology is described as siltstone and shale with pyrite, radiolarians, and spicules. No specific foraminifer species are noted. Based on lithology, this interval would also be consistent with the Miguelito Member, Monterey Formation, or possibly the Rincon Formation.

Silty sandstone is described from 1,486 to 1,564 feet. Again, pyrite, radiolarians, and spicules are present. No specific foraminifer species are noted. Based on lithology this interval would be most consistent with either the Edna Member of the Pismo Formation or the Vaqueros Sandstone.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation interpretation, is presented in Table E3-2. See Plate E1 for a graphical log of the Maino-Gonzales 1 well.

**Table E3-2. Summary Interpretation of the Maino-Gonzales 1 Well**

| Depth (ft.) | Formation | Lithology (from paleontology report) | Confidence |
|---|---|---|---|
| 0 to 36 | Alluvium | Surface wash | High |
| 36 to 100 | Pismo Miguelito Member, or Monterey | Siltstone and shale | High |
| 100 to 1,047 | Pismo Miguelito Member, or Monterey | Cherty siltstone and shale | Moderate to Low |
| 1,047 to 1,486 | Pismo Miguelito Member, or Monterey or Rincon | Siltstone and shale with pyrite | Low to Moderate |
| 1,486 to 1,564 | Pismo Edna Member, or Vaqueros | Silty sandstone | Low |
| 1,564 to 1,575 | Franciscan serpentine | Serpentinized schist | High |

## E3.3 API 07900310, Pecho 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEARS DRILLED: 1927 and 1937

TOTAL DEPTH: 2,745 ft. (837 m)

ELEVATION, TOP OF WELL: Approx. 176 ft. (54 m)

SOURCES OF DATA: DOGGR files, Hall (1982), CSUB Well Repository

AVAILABLE DATA: History file, including well summary record, brief lithologic log, report of abandonment, and paleontology report by Union Oil Co. of California

The well originally was drilled to 2,287 feet by the Painted Oil Company in 1927. Unfortunately, there are no records of this original well. A.O. Lewis reoccupied the well in 1937 and deepened it to 2,745 feet. Thus, geologic information exists for the lower ~450 feet of the well. The well is described as a "surface anticline play."

LOCATION: The well history file reports the location of the Pecho 1 well at 1,339 feet south and 1,203 feet west from the southwest corner of Section 26, T30S-R10E, and at an elevation of 177 feet measured from the derrick floor. Plotting this location in ArcGIS shows it to be approximately 75 feet of the location in the DOGGR database, with both locations on a ridge directly north of Islay Creek at an elevation of approximately 200 feet (Figure E2-4) and the PLS location corresponding to a LiDAR elevation of 211 feet. The 7.5-minute USGS topographic map marks a "drill hole" approximately 200 feet west-southwest of the PLS-based location (Figure E2-4). The LiDAR elevation of this point is 171 feet, a much better match to the elevation from the well history report. Thus, the best estimate well location used in this study is the location provided on the USGS topographic map. Assuming the derrick floor is approximately 5 feet above the ground, the top of the well (at the derrick floor) is at

approximately 176 feet elevation. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift angles. For the Pecho 1 well, which is approximately 2,700 feet deep, Table E2-3 suggests an additional ±240 feet uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: According to the GMP geologic map and the mapping of Hall (1973a), the well spudded in a thin veneer of marine terrace deposits overlying the Miguelito Member of the Pismo Formation near the mouth of Islay Creek (Plate 1 of main report). The well is located approximately 2 km north-northeast of the Monterey-Pismo Formation contact at Coon Creek near Point Buchon, and approximately 3.5 km west of the breached anticline described in Section E3.2 above in the discussion for the Maino-Gonzales 1 well.

Stratigraphic information is available only for the interval from 2,287 to 2,745 feet. The Log and Core Record notes "hard brown shale" with "hard sand," and the paleontology report describes the rock as "dark and light brown banded platy silt shale," consistent with the lithology of the Monterey Formation or Miguelito Member of the Pismo Formation. The paleontology report noted no fossils in the three core samples examined.

The base of the Pismo Formation may be somewhere between 0 and 2,287 feet, or lower. Based on the well depth and distance from the mapped Pismo-Monterey Formation contact, the contact would have to have an average northeast dip of approximately 20 degrees or less to be encountered in the Pecho 1 well. Based on the numerous anticlines and synclines with moderately dipping limbs between the well and the contact, this is certainly plausible. Hall (1982) considers the entire well to be upper Miocene, and does not attempt to estimate the depth of the contact between the Pismo and Monterey Formations. With the information provided it is permissible that the entire well is within the Miguelito Member of the Pismo Formation; likewise it is permissible that the Pismo-Monterey Formation contact is within the upper several hundred feet and the rest of the well is within Monterey Formation.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-3. See Plate E2 for a graphical log of the available data for the Pecho 1 well.

**Table E3-3. Summary Interpretation of the Pecho 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 2,287 | Pismo Formation, Miguelito Member, possibly containing contact with Monterey Formation | ND. Records for this interval are missing. | Low |
| 2,287 to 2,745 BOH | Pismo Formation, Miguelito Member, or Monterey Formation | Hard, dark and light brown banded, platy silt shale | Low |

## E3.4 API 07900378, Mello 2

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1955

TOTAL DEPTH: 1,505 ft. (459 m)

ELEVATION, TOP OF WELL: Approx. 217 ft. (66 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: History file, including well summary record; core log; e-log

LOCATION: The location provided in the DOGGR file, placing the well adjacent to Pismo Creek near the head of Price Canyon, was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 213 feet. The reported offset between ground surface and top of well is 4 feet. Thus, the preferred elevation of the top of the well is 217 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift angles. For the Mello 2 well, which is approximately 1,500 feet deep, Table E2-3 suggests an additional ±130 feet uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: According to the mapping of Hall (1973b), the well spudded in alluvium of Pismo Creek overlying the Edna Member of the Pismo Formation near the head of Price Canyon. Monterey Formation is mapped directly north of the Mello 2 well as a fault-bounded sliver against Edna Member sandstone. Most dips at the surface are moderate to the south-southwest, and the relatively straight fault traces suggest moderately to steeply dipping faulting; likely to the south as well.

According to the Well Summary Report, The Mello 2 well penetrates Pismo(?) between 0 and 380 feet, Monterey Formation between 380 feet and approximately 1,400 feet, and "Relizian(?)" between 1,400 feet and 1,505 feet. Cores from 400 to 1,200 feet show sandstone, shale, conglomeratic siltstone, and silty sandstone locally with sandstone locally impregnated with tar that is consistent with the Edna Member mapped at the surface by Hall (1973b) but also may be consistent with Monterey Formation. Dips reported in this interval are moderate (35 to 68 degrees). Cores from 1,304 to 1,325 feet show interbedded rhyolite tuff and sandstone, and a rhyolite/siltstone breccia. This lithology may be consistent with Monterey Formation but is also consistent with the bedded, fine-grained facies of the Obispo Formation. The closest Obispo Formation is mapped approximately 4 km northwest of the well along the Edna–Los Osos fault zone and 5 km south-southwest of the well near the mouth of Price Canyon. No lithologic data could be found for the 1,400–1,500 foot interval except a handwritten note on the e-log that describes it as brown clay shale. The formation names were assigned in the well summary report.

The Relizian age stated in the Well Summary Report would be most consistent with Obispo Formation elsewhere in the Pismo Basin, but may also be consistent with Monterey Formation.

Sweetkind et al. (2010) provide an alternative interpretation of this well to the simple stratigraphy in the well history report. First, they place the top of the Monterey Formation at 980 feet instead of 380 feet. This may be a typographical error as there is no significant stratigraphic change noted at 980 feet in the well log. Second, they assign the rhyolite tuff bed encountered at approximately 1,305 feet along with all underlying strata to the Obispo Formation. Hall (1973b) shows tuff interbeds to be common in the lower Monterey Formation. Thus, it is permissible that Monterey Formation is present to the bottom of the well.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-4.

**Table E3-4. Summary Interpretation of the Mello 2 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 380 | Pismo Formation, Edna Member | | High |
| 380 to 1,305 | Pismo Formation, Edna Member, possibly faulted with Monterey Formation | 400–1,200 ft: sandstone, shale, conglomerate, siltstone; Pebble bed at 1,000 ft. | Moderate |
| 1,305 to 1,400 | Obispo Formation or Monterey Formation | 1,304-1,325 ft: rhyolite tuff, sandstone, rhyolite/ siltstone breccia | Moderate to Low |
| 1,305 to 1,505 BOH | Obispo Formation or Monterey Formation | Brown clay shale; “Relizian(?)” noted in Well History Report | Moderate to Low |

## E3.5 API 07900380, Spooner 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1953

TOTAL DEPTH: 1,749 ft. (533 m)

ELEVATION, TOP OF WELL: Approx. 527 ft. (161 m)

SOURCES OF DATA: DOGGR files, Hall (1982; pers. comm., 2011), Brunetti (pers. comm., 2013), CSUB Well Repository

AVAILABLE DATA: History file, including driller’s log (no geologic or lithologic log); e-log; micro log; paleontology report by F. Crawford of Union Oil Company of California

LOCATION: This well has been located precisely in the field by GMP geologists (Figure E2-3). Prior to being located in the field, it was suspected that the well was mislocated in the DOGGR database. It is shown approximately 1,000 feet too far down the slope to the north, putting it on the north side of the Los Osos fault and at a low elevation. The USGS topographic map (Hall, 1973a) has marked it more correctly at an elevation of approximately 500 feet, close to its reported elevation of 462 feet. In 2012, the wellhead was located in the field by GMP geologists

and GPS coordinates were obtained. The true location is indeed close to the location marked on the USGS topographic map, and it lies on the south side of the mapped trace of the Los Osos fault. The LiDAR-based elevation from the project DEM is 522 feet at the ground surface, much higher than the reported elevation. The estimated offset between ground surface and top of well is 5 feet. Thus, the preferred elevation of the top of the well is 527 feet. The uncertainty in this well location is estimated to be ±3 feet (1 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

The differences between the DOGGR database and the measured location of the Spooner 1 well is very large: 296 m horizontal difference between the measured location and the DOGGR database reported location. Such large uncertainties are hypothesized to result from an error introduced during the reporting of the well location or during the digitization process to create the DOGGR database. The very large difference between the elevation reported in the well history file (141 m) and the elevation from the LiDAR data at the location reported in the well history file (108 m) was flagged as problematic during the evaluation phase of the project, and led to a more thorough investigation into possible errors in the database well location. This investigation ultimately led to the request that the GMP map team locate the well in the field.

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift angles. For the Spooner 1 well, which is approximately 1,750 feet deep, Table E2-3 suggests an additional ±150 feet uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: According to the GMP geologic map and the mapping of Lettis and Hall (1994) and Wiegers (2009), the well spudded in aeolian deposits flanking the northern slope of the Irish Hills directly north of Hazard Canyon. Small outcrops of the Miguelito Member of the Pismo Formation are present within 300 to 400 m east and west of the Spooner 1 well, and a continuous body of Miguelito is located approximately 500 m south of the well (Plate 1 of main report). Section E3.2 describes the map relations important to consider for interpreting the nearby Maino-Gonzales 1 well located approximately 500 m to the south of the Spooner 1 well.

Stratigraphic interpretations are based on consideration of the geologic map; the paleontology report, which included notes on lithology and benthic fauna below a depth of 600 feet; the driller's descriptions of the materials encountered at four depths; a continuous e-log that provided depths of major stratigraphic changes; and a microlog for the interval from 700 to 1,300 feet.

No log information is available from the surface down to 201 feet. The well spudded in Quaternary aeolian sands, then the driller lost circulation in a coarse gravel at 200 feet. They set casing from the surface to 210 feet. We interpret the upper 210 feet to be Quaternary materials, beginning with the aeolian deposits at the surface and ending with porous fluvial gravels at 200 feet. Such alluvial deposits may be correlative to Quaternary "older alluvium" or Paso Robles Formation.

From 210 to 820 feet a unit with a fairly uniform low resistivity was encountered. The paleontology report describes the interval from 500 to 820 feet as shale and sand with some limestone. A sample from 790 feet is described as sand, even-grained, porous, and permeable. At the base of the unit, 809 to 814 feet depth, the log notes Monterey shale fragments deposited in sand, then a contact with the top of the Monterey Formation at 820 feet, a clear unconformity. We note again that at the time of drilling, the Miguelito Member had not been described and convention was to include what is now Miguelito Member within the Monterey Formation. The e-log shows a peak in resistivity at 800 feet, which may reflect the sand layer from 790 to 820 feet, underlain by a unit with alternating resistivity. We interpret the interval from 200 to 820 feet to belong to the upper part of the Pismo Formation or equivalent shallow marine Pliocene deposits, which may include the Squire Member sandstone, Bellevue Member claystone to fine sandstone, or Gragg Member fine to medium sandstone (Hall, 1973a). These units, and the age-correlative Careaga Formation, are typically weakly to moderately lithified marine deposits that would be indicative of the uniform low resistivity. It is puzzling to note the absence of Miguelito Member in the well down to 820 feet given the mapped Miguelito Member outcroppings near the Spooner 1 well. It is plausible that these exposures were misidentified, or alternatively, that upper Pismo Formation units are benched locally into the older lower Pismo Formation Miguelito Member.

From 820 to 1,300 feet, the material exhibits alternating resistivity, as typically encountered in interbedded mudstone, siltstone, and shales of the Miguelito Member and Monterey Formation. The paleontology report notes brown shale with some sandstone and limestone beds. Benthic foraminifera of early Mohnian age are present, consistent with both the lower portion of the Miguelito or the Monterey Formation. The geologic context of the well would favor an interpretation of Miguelito Member, but a true early Mohnian age would favor a Monterey Formation interpretation based on the approximately 10 Ma age of the contact at Coon Creek/Point Buchon.

From 1,300 to approximately 1,600 feet, a similarly alternating resistivity is observed in a more widely spaced pattern than above. Sand and shale are logged at 1,370 feet in a 16-foot length of core. The paleontology report notes that shale, siltstone, limestone, and sandstone are found throughout, with sandstone increasing below 1,400 feet with Mohnian fauna. The lithologies are consistent with the interfingering of the Miguelito and Edna Members of the Pismo Formation, with increasing Edna sandstone at depth. This is equivalent to the map relations seen along structural trend to the southeast (Plate 1 of main report). However, alternative interpretations are possible, including placing this sequence within the Monterey Formation, or assigning the lower fine sandstone to the Vaqueros Formation. Hall (1982), however, thought that the Franciscan Complex had been encountered at 1,300 feet, based on correlation with surface mapping.

In his letter dated August 2011 (see electronic Section E8.1), Hall explains his reasoning:

> Tpm at “Spooner” 1 rests unconformably on the Franciscan Complex, specifically greywacke (KJgw2). KJgw2 crops out approximately 1.5 miles east of the well site. The Monterey, Obispo, Rincon, and Vaqueros formations thin to the west in this region and pinch out westward before the well site (MF-511 and USGS Map I 1097). The 1,300-foot depth from the well log (DOG) is agreement with a cross section drawn through the area; also, note Cross Section A—A″ on map sheet

511. Elsewhere in the general area the Miguelito Member rests unconformably on metavolcanic rocks of the Franciscan Complex.

We feel this evidence is not as strong as the observations of lithology and benthic fauna contained in the paleontology report, which Hall may not have been aware of.

The paleontology report places the contact between Monterey Formation and underlying Franciscan sandstone at 1,610 feet, based on ditch samples and the e-log. The Franciscan sandstone is described as medium to coarse varicolored sandstone. We note that this unit may also be Vaqueros Formation, which is mapped along trend within the breached anticline to the southeast. The Franciscan graywacke or Vaqueros Formation contact could be as high as 1,520 feet, based on description of coarse to medium sandstone at 1,535 and 1,590 feet and on the e-log signature. However, common to abundant benthic fauna of Mohnian age are recorded at 1,590 feet, supporting the contact at 1,610 feet.

Some Mohnian-age benthic fauna are also noted below 1,610 feet, however, it is likely that these were derived from higher in the hole. The samples described in the paleontology report were ditch samples rather than core samples. We concur with the placement of the top of the Franciscan graywacke or Vaqueros Formation at 1,610 feet, but note that the contact may be approximate and the formation top is non-unique.

At 1,745 feet, serpentinite is logged in the core, indicating that basement has been reached by that depth. Serpentinite of the Franciscan Complex continues to the bottom of the hole at 1,749 feet. The serpentinite crops out at the base of the Tertiary section within the breached anticline southeast of the well.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation interpretation, is presented in Table E3-5. See Plate E3 for a graphical log of the Spooner 1 well.

**Table E3-5. Summary Interpretation of the Spooner 1 Well**

| Depth (ft.) | Formation | Lithology (from paleontology report) | Confidence |
|---|---|---|---|
| 0 to 210 | Quaternary aeolian and fluvial sediments | Coarse gravel at 200 to 210 ft. | Moderate to High |
| 210 to 820 | Pismo Formation, Squire and/or other upper members | Sand, shale, and limestone | Moderate |
| 820 to 1,300 | Pismo Formation, Miguelito Member or Monterey Formation | Brown shale with lower Mohnian fauna | Low to Moderate |
| 1,300 to 1,520 | Pismo Formation, Miguelito Member, and/or Pismo Formation, Edna Member, or Monterey Formation | Shale, limestone, and sandstone with Mohnian fauna | Low to Moderate |
| 1,520 to 1,610 | Pismo Formation, Edna Member, or Monterey Formation or Vaqueros Formation or Franciscan graywacke | Sandstone with Mohnian fauna | Low to Moderate |
| 1,610 to 1,745 | Vaqueros Formation or Franciscan graywacke | Sandstone | Moderate |

| Depth (ft.) | Formation | Lithology (from paleontology report) | Confidence |
|---|---|---|---|
| 1,745 to 1,749 | Franciscan Complex serpentinite | Serpentinite | High |

## E3.6 API 07900471, Bassi Core Hole 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1962

TOTAL DEPTH: 959 ft. (292 m)

ELEVATION, TOP OF WELL: Approx. 208 ft. (63 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: E-log with some hand notations

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 203 feet. The estimated offset between ground surface and top of well is 5 feet. Thus, the preferred elevation of the top of the well is 208 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

STRATIGRAPHY: According to the GMP geologic map and the mapping of Hall (1973b), the well spudded in the Squire Member of the Pismo Formation, within the core area of the Pismo syncline. Locally, the three Pliocene upper members of the Pismo Formation (Squire, Bellevue, and Gragg from highest to lowest) form a broad basin with the long synclinal axis trending east-west, which is approximately 30 degrees rotated from the more west-northwest/south-southeast-trending Pismo syncline in underlying lower Pismo Formation (mostly Miguelito Member). South of the broad upper Pismo Formation basin, Monterey Formation crops out, and north of the broad upper basin Miguelito Member, Pismo Formation crops out. The map relations indicate an angular unconformity between the upper members of the Pismo Formation and underlying Monterey Formation (to the south and southwest) and lower Pismo Formation (to the north).

The well information is restricted to an e-log with handwritten notes. The notes include dark gray claystone at 500 feet depth and light gray well sorted claystone and sandstone at 750 feet. The third handwritten note indicates the Pismo-Monterey Formation contact at 670 feet coinciding with an increase in the average values and amplitudes of the resistivity log. Sweetkind et al. (2010) concurs and notes this depth as the top of the Monterey Formation. However, the well is located on the north side of the east-west-trending syncline axis, and is more likely to encounter Miguelito Member of the Pismo Formation than Monterey Formation below the upper Pismo Formation strata. It is also unclear if the well penetrated the entire upper part of the Pismo Formation, as explained below.

The alternative stratigraphic interpretations for the Bassi Core Hole 1 well are explored using a simple map analysis of the doubly-plunging syncline in the upper Pismo Formation strata. The hole is on the north side of the longer, east-west-trending syncline axis, with the measured dips

within the limbs of the syncline typically between approximately 20 degrees and 30 degrees (Hall, 1973b). The first hypothesis is that the change in resistivity at 670 feet depth is due to the change from less consolidated, Pliocene upper Pismo Formation members overlying more lithified and well bedded Miguelito Member. The distance from the well to the Miguelito Member-upper Pismo Formation (Gragg Member) contact is approximately 2,000 feet, which suggests the limb would have an average dip of 18 or 19 degrees to encounter Miguelito Member at 670 feet depth. This is certainly permissible within the range of dips shown on the map. Alternatively, the distance from the well to the Squire-Bellevue contact is approximately 1,500 feet. If the change in resistivity is due to the contact between the more massive, sandy Squire Member and the bedded buff to gray claystone and fine sandstone Bellevue Formation, the average dip of the limb is approximately 24 degrees. With a 24-degree dip, the total depth of the well—959 feet—would correspond to approximately the Miguelito-Gragg Formation contact. This, too, is permissible given the dips noted on the geologic map. Table E2-6 provides a summary of the alternative interpretations, including a qualitative measure of confidence in the preferred interpretation.

**Table E3-6. Summary Interpretation of the Bassi Core Hole 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 670 | Pismo Formation, Squire Member, or Pismo, upper members (Squire, Bellevue, and Gragg) | Claystone at 500 ft. | Moderate |
| 670 to 959 BOH | Pismo Formation, Bellevue and Gragg Members, or Pismo Formation, Miguelito Member | Claystone and sandstone at 750 ft. | Moderate |

## E3.7 API 07900477, Honolulu-Tidewater 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1958

TOTAL DEPTH: 10,788 ft. (3,289 m)

ELEVATION, TOP OF WELL: Approx. 1,642 ft. (500 m)

SOURCES OF DATA: DOGGR files, Hall (1982), Chevron-Texaco (L. Knauer, pers. comm., 2013)

AVAILABLE DATA: History file; lithologic log and core record; e-log; dip log, including deviation information; paleontology report by Union Oil Company of California (1958)

LOCATION: The wellhead was located in the field in 2012 by GMP geologists (Figure E2-5). The coordinates shown in the ArcGIS shapefile and on Plate E4 are taken from the on-the-ground GPS measurements at the wellhead. The true location is approximately 240 feet northwest of the location provided in the DOGGR database, and relatively close to the point marked “Drill Hole” on the USGS 7.5-minute topographic map (Figure E2-5). The LiDAR-based elevation from the project DEM is 1,630 feet at the ground surface. The offset between ground surface and the Kelly bushing provided in the history file is 12 feet. Thus, the preferred elevation of the top of

the well is 1,642 feet. The uncertainty in this well location is estimated to be ±3 feet (1 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

Deviation information for the Honolulu-Tidewater 1 well is included with the dip log. Section E2.4 describes the approach for constructing a deviation log from these data, and Figure E2-8 shows plots of the results. The results show that, on average, the drilling angle was about three degrees from vertical, with the drift angle varying from zero to a maximum of 9.5 degrees. The estimated difference in location at the bottom of the hole compared to the top of the well is 220 feet to the east and 220 feet to the south. An Excel file containing the deviation log that may be used for plotting the drift information correctly is included as Appendix E4.

STRATIGRAPHY: At 10,788 feet, this is the deepest well in the Irish Hills, drilled at the crest of a ridge in the center of the Pismo Syncline. Despite its great depth, the well did not reach basement rock. A graphic compilation of well log information is presented in Plates E4a and E4b.

According to the GMP geologic map and the mapping of Hall (1973a), the well spudded in the Miguelito Member of the Pismo Formation, within the core area of the Pismo syncline. The 1958 well log states that it begins in the upper Monterey Formation, consistent with the stratigraphic framework at that time, prior to the recognition of the unconformity-bounded Pismo Formation. The contact between the Miguelito Member and the Monterey Formation is unclear. Hall (1982) estimates the contact to be at approximately 100 feet depth but provides no rationale. We conclude that some portion of the unit identified in 1958 as the Upper Monterey Formation belongs to the Miguelito Member of the Pismo Formation, and designate the interval from a depth of approximately 100 to 1,037 feet as belonging to either unit.

Samples were collected and analyzed for microfossils by paleontologists C.E. Sturz and Louis Simon. The samples in general contained meager fauna, with many samples barren. Samples from 20 to 560 feet depth contained Mohnian fauna consistent with Monterey or Pismo Formations. Samples from the shale beds at 5,400 to 5,600 feet contained Zemorrian fauna, consistent with Rincon Shale. Samples from 6,420 to 10,180 feet contained Saucesian fauna consistent with Obispo Formation (tuff, tuffaceous dolomitic sandstone and siltstone) or Rincon Formation. Kristin McDougall examined the fauna in the report and noted that the fauna in the interval from 5,400 to 5,600 feet seem older than the fauna from deeper in the hole (McDougall, pers. comm., 2013), suggesting an older-over-younger fault relation.

The well log data suggest complex folding and faulting below the base of the Monterey Formation (Plate E4). Of particular note are changes in dip, the repeated stratigraphic sections, and the extreme thickness of the second Rincon shale (3,820 feet, instead of the more typical 500 feet measured by Hall, 1973a). Several prominent changes in dip direction are observed in the dip log. The change in dip at around 5,440 feet may be a fault or other structure within the Rincon shale. The core log reports that the rock is “moderately fractured and slickensided at varying angles.” Dips above this interval had been steep to the south. Immediately below this interval, dips are to the northeast. Another dip change that corresponds to slickensides described in the core occurs at 9,000 feet within the second Rincon shale.

The base of the Tertiary is estimated to be at approximately 12,000 feet (3,666 m) depth in the well, assuming that the top of the second tuff is the top of the Obispo Formation, and that the

Obispo Formation, Rincon Formation, and Vaqueros Formation together comprise 1,850 feet. We note this approximation is very crude.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-7. See Plate E4 for a graphical log of the available data for the Honolulu-Tidewater 1 well.

**Table E3-7. Summary Interpretation of the Honolulu-Tidewater 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 1,037 | Pismo Formation, Miguelito Member, possibly containing contact with Monterey Formation | Silt shale, with dolomite, clay shale, limestone, chert, and bentonite | High |
| 1,037 to 4,363 | Monterey Formation | Silt shale and dolomite with minor chert<br>Brecciated at 3,080 ft. | Moderate |
| 4,363 to 4,722 | Obispo Formation | Silt shale with dolomite, with minor sandstone and bentonite | Moderate to Low |
| 4,722 to 5,370 | Obispo Formation | Tuff, with bentonite, sandstone, obsidian | High |
| 5,370 to 5,546 | Rincon Formation | Siltstone with foraminifera<br>Fault at 5,500 ft.? | Moderate |
| 5,546 to 6,354 | Obispo Formation | Tuff, lithic and crystalline, siltstone, bentonite and obsidian, limestone | Moderate |
| 6,354 to 10,174 | Rincon Formation or Obispo Formation | Siltstone, with some tuff<br>Fault at 9,000 ft.? | Low to Moderate |
| 10,174 to 10,788 BOH | Obispo Formation or Rincon Formation | Tuff with silt shale | Low to Moderate |

## E3.8 API 07900478, Montadoro 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1954

TOTAL DEPTH: 6,146 ft. (1,874 m)

ELEVATION, TOP OF WELL: Approx. 381 ft. (116 m)

SOURCES OF DATA: DOGGR files, Hall (1982), Brunetti (pers. comm., 2013)

AVAILABLE DATA: History file, including core log; e-log

LOCATION: The Montadoro 1 well is reported to be located 6,900 feet S and 1,850 feet W from the SW corner of Section 26, T30S, R10E, at an elevation of 375 feet at the "table." The height of the table is reported to be 10 feet above the ground surface, therefore the ground surface elevation is approximately 365 feet. The well location plotted from the PLS coordinates in

ArcGIS is approximately 350 feet southeast of the location shown in the DOGGR database (Figure E2-6). The LiDAR-based elevation from the project DEM at the PLS-based location is 371 feet. Adding the 10-foot offset stated in the history file yields an elevation of 381 feet for the top of the Montadoro 1 well. The uncertainty in this well location is estimated to be ±300 feet (100 m). The elevation uncertainty is estimated to be ±20 feet (7 m).

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift angles. For the Montadoro 1 well, which is approximately 6,150 feet deep, Table E2-3 suggests an additional ±530-foot uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: The Montadoro 1 well is located near the center of the Pismo Syncline and penetrates a thick section of Miocene sediments. Similar to the Honolulu-Tidewater 1 well, the well does not reach basement. A graphic log of the information available for the Montadoro 1 well is provided on Plate E5.

According to the GMP geologic map and mapping by Hall (1973a), the well spudded in Miguelito Member of the Pismo Formation. Hall's (1982) interpretation of the well places the base of the Pismo Formation at 200 feet but provides no rationale. We place a tentative contact at 1,700 feet based on a break in the e-log and a core sample description at 1,800 feet that is consistent with Monterey Formation. However, we acknowledge that the contact is approximate.

The base of the Monterey Formation is clearly indicated by a break on the e-log at 3,800 feet, with a corresponding change in lithology to the tuff of the Obispo Formation (Plate E5). Shale intervals are logged along with the tuff to a depth of 4,972 feet, where sandstone and tuffaceous shale beds are encountered. Hall (1982) places an interval of Rincon shale here and interprets a fault at the base of the interval at 5,155 feet, perhaps interpreting that the Obispo Formation repeats section. We consider that these sandstone and shale beds may be interbeds within the Obispo Formation similar to the tuffaceous to dolomitic and sandstone to siltstone interbeds mapped along the coast south of Point Buchon. Dr. Hall (pers. comm., 2011) was contacted requesting more information, but he was not able to shed any additional light on his interpretation of this well except to say that the log information was from notes taken at the DOGGR (Appendix E3).

Below 4,972 feet, beds of tuff, sandstone, and shale continue to the base of the well at 6,142 feet. This interval may be a continuation of the Obispo Formation, but could alternatively be interpreted as Rincon Formation with tuffaceous interbeds. Gouge and slickensides are common in this interval.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-8. We note that, aside from the top of the Obispo Formation at approximately 3,800 feet, all formation contacts are approximately located and uncertain. See Plate E5 for a graphical log of the available data for the Montadoro 1 well.

**Table E3-8. Summary Interpretation of the Montadoro 1 Well**

| Depth (ft.) | Formation | Lithology* | Confidence |
|---|---|---|---|
| 0 to 1,700 | Pismo Formation, Miguelito Member, possibly containing contact with Monterey Formation | ND, not logged | High |
| 1,700 to 3,800 | Monterey Formation, possibly containing contact with Pismo Miguelito | Shale, limestone, and chert | Moderate |
| 3,800 to 4,972 | Obispo Formation | Tuff | High |
| 4,972 to 6,146 BOH | Obispo and/or Rincon Formations | Shale and tuff, with gouge and slickensides common throughout, especially near 6,000 ft. | Low to Moderate |

* Lithology is based on descriptions of core samples taken of various intervals. No continuous lithologic log was found in the records. Contact locations are interpreted primarily from changes in the e-log signature.

## E3.9 API 07900486, Heller Core Hole 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1962

TOTAL DEPTH: 1,305 ft. (398 m)

ELEVATION, TOP OF WELL: Approx. 225 ft. (69 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: History file with well summary and core descriptions (completion report); e-log

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 220 feet. The reported offset between ground surface and top of the well (measured to the derrick floor is 4 feet. Thus, the preferred elevation of the top of the well is 224 feet. The reported elevation is 279 feet, suggesting additional uncertainty in the well location. Thus, the uncertainty in this well location is estimated to be ±600 feet (180 m). The uncertainty in elevation is estimated to be ±70 feet (21 m).

STRATIGRAPHY: According to the geologic map by Hall (1973b), the well spudded in the Miguelito and Edna Members of the Pismo Formation approximately at the contact with the overlying Gragg Member of the Pismo Formation. The intermediate dips to the north (approximately 25 to 35 degrees) and the map suggest the well should encounter mostly Edna Member sandstone overlying and interbedded with siltstone and claystone of the Miguelito Member with Monterey Formation at depth.

Four cores were recovered from approximately 400 to 630 feet depths that are described as containing silty sandstone (at approx. 400 ft. depth) to siltstone and claystone (below 400 ft.). The completion log also reports sidewall samples with sand and tar sand from 150 feet depth to approximately 310 feet, then silty claystone and siltstone from approximately 320 to 1,230 feet depth. The e-log shows a major break at approximately 310 feet that coincides with the lithology change reported in the sidewall core. There is no indication in the core log that chert or siliceous shale was encountered in the siltstone interval, and there are no formation interpretations provided in the history file.

Based on the information from the geologic map, e-log, and the sidewall core, we interpret a contact between Edna Member and Miguelito Member of the Pismo Formation at approximately 310 feet depth. The consistency in the sidewall core descriptions and the spontaneous potential log suggests Miguelito Member is present to the bottom of the well, although we cannot rule out that the Miguelito-Monterey Formation contact may be present in the lower portion of the well, perhaps below the depth of the last sidewall core sample. A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-9.

**Table E3-9. Summary Interpretation of the Heller Core Hole 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 310 | Pismo Formation, Edna Member | Sandstone, silty, hard with tar coatings on fractures | High |
| 310 to 1,305 BOH | Pismo Formation, Miguelito Member; possibly including contact with Monterey Formation near the bottom of the well. | Siltstone, claystone, Siltstone, hard | High to Moderate |

## E3.10 API 07900550, Townsend-Gunter 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1956–1957

TOTAL DEPTH: 3,286 ft. (1,002 m)

ELEVATION, TOP OF WELL: Approx. 571 ft. (174 m)

SOURCES OF DATA: DOGGR files, Hall (1982; pers. comm., 2011)

AVAILABLE DATA: History file, including well summary report; e-log; caliper log; orientation log

LOCATION: The location provided in the DOGGR file was accepted for this project. Hall (1973b) shows a drill hole symbol approximately 275 feet to the north-northeast that may be an alternative location for the well. The LiDAR-based elevation from the project DEM for the DOGGR location is 567 feet. The LiDAR-based elevations for the nearby well shown by Hall (1973b) are similar to the elevations at the DOGGR location. The reported offset between ground surface and top of well is 4 feet. Thus, the preferred elevation of the top of the well is 571 feet. The reported elevation is 493 feet, suggesting additional uncertainty in the well location.

We estimate the uncertainty in this well location to be ±600 feet (180 m). The uncertainty in elevation is estimated to be ±90 feet (27 m).

STRATIGRAPHY: According to the GMP geologic map and Hall (1973b), the well spudded in Miguelito Member (DOGGR location) or Edna Member (Hall (1973b) location) of the Pismo Formation on the north-eastern limb of the Pismo syncline, within a secondary fold structure called the See Canyon anticline. According to Mr. Townsend's 1957 letter to the CaDOG, its target was the Vaqueros sandstone, with a secondary objective to determine the depth to basement in the See anticline. The 1957 well summary report provides the depths of the top of the Monterey Formation, Obispo Formation, and basement. Reported dips from cores include 40 to 60 degrees at 2,500 feet (within Obispo Formation). Hall (1982) interprets the well to begin in the Pismo Formation, and he places the top of the Vaqueros Formation sandstone at 2,750 feet and the top of the Franciscan Complex (KJf) at 2,950 feet. In his August 2011 letter (electronic Section E8.1), Hall reports that he relied on the geologic mapping and measured thicknesses of the units in local outcrops to interpret the depths of the top of the Vaqueros sandstone and Franciscan graywacke. Table E3-10 provides a summary interpretation of the well.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-10.

Edna fault dip: The top of serpentinite bedrock in this well could be interpreted to mark the location at depth of the Edna fault. Assuming a horizontal distance from the well to the fault trace at the surface of 2,200 to 2,300 feet, and a depth of the fault in the well of 3,270 feet, the dip of the Edna fault is approximately 55 degrees to the south-southwest. This interpretation is not unique, so this model-estimated dip of the Edna fault should be considered with caution.

**Table E3-10. Summary Interpretation of the Townsend-Gunter 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 805 | Pismo | ND | High to Moderate |
| 805 to 1,105 | Monterey (lower Mohnian) | Fractured shale | Low to Moderate |
| 1,105 to 2,750 | Obispo (and Rincon?) | Tuff | High to Moderate |
| 2,750 to 2,950 | Vaqueros Sand | ND | Low to Moderate |
| 2,950 to 3,270 | Franciscan Complex | "Hard sedimentary rock" | Low to Moderate |
| 3,270 to 3,286 BOH | Franciscan Complex | Serpentinite | High |

## E3.11 API 07900551, Townsend-Peterson 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1956

TOTAL DEPTH: 1,445 ft. (440 m)

ELEVATION, TOP OF WELL: Approx. 129 ft. (39 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: History file, including ditch log and well summary report; e-log

LOCATION: The location provided in the DOGGR file was accepted for this project. Hall (1973b) shows two wells located approximately 1,100 and 1,200 feet north of the DOGGR location suggesting alternative locations. The LiDAR-based elevation from the project DEM for the preferred location is 125 feet, and elevations for the alternative Hall (1973b) boring locations are higher. The reported offset between ground surface and top of well is 4 feet. Thus, the preferred elevation of the top of the well is 129 feet. The reported elevation for the top of the well is 87 feet, indicating there is additional uncertainty in the well location and the locations proposed by Hall (1973b) are not necessarily preferred. We estimate the uncertainty in this well location to be ±600 feet (180 m). The uncertainty in elevation is estimated to be ±50 feet (15 m).

STRATIGRAPHY: According to the GMP geologic map and Hall (1973b), the well spudded in the Miguelito Member of the Pismo Formation near the core of the Pismo syncline. Sweetkind et al. (2010) place the top of the Monterey Formation at the base of this well at 1,445 feet. However, there is no record in the ditch log or well summary report of the Monterey Formation. In our preferred interpretation, the Monterey Formation contact is assumed to be at some depth below the base of the well. Table E3-11 provides a summary interpretation of this well.

**Table E3-11. Summary Interpretation of the Townsend-Peterson 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 1,455 BOH | Pismo Formation (Miguelito Member) | Siltstone, silty shale, with dolomite, and some porcelanite | High to Moderate |

## E3.12 API 07900581, Sousa 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1955

TOTAL DEPTH: 1,233 ft. (376 m)

ELEVATION, TOP OF WELL: Approx. 45 ft. (14 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: History file, including lithologic log and sketch interpretation; e-log

LOCATION: The well location is described as being 200 feet west of the road and 187 feet NW of the property line shown on a sketch map in the well record. This location, plotted using ArcGIS, is shown on Figure E2-7, and is located approximately 342 feet west of the point shown in the DOGGR database. The elevation of the ground surface at the well is reported to be 42 feet. The elevation at the location according to the well record is 39 feet. The reported offset between ground surface and top of well is 6 feet. Thus, the preferred elevation of the top of the well is 45 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift angles. For the Sousa 1 well, which is approximately 1,200 feet deep, Table E2-3 suggests an additional ±105 feet uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: According to the GMP geologic map, Wiegers (2009), and Hall (1973a), the well spudded in thin alluvium overlying Franciscan Complex rocks near the boundary between metavolcanic rocks and mélange. The lithologic log indicates clay and gravelly alluvium overlying hard to very hard sandstone and shale of the Franciscan Complex to a depth of 1,234 feet. Some soft shale interbeds are noted. A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-12.

**Table E3-12. Summary Interpretation of the Sousa 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 50 | Quaternary alluvium | Clay and gravel | High |
| 50 to 1,234 | Franciscan Complex | Hard sandstone and silty shale | High |

## E3.13 API 07900591, Signal ETS 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1954

TOTAL DEPTH: 1,168 ft. (356 m)

ELEVATION, TOP OF WELL: Approx. 224 ft. (68 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: History file and e-log

*CADOGGR database shows a depth of 1,768 feet, transcribed from the well summary report. This is probably an error. The driller's history report describes drilling only to 1,168 feet, and the e-log goes to 1,123 feet.

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 220 feet. The reported offset between ground surface and top of well is 4.4 feet. Thus, the preferred elevation of the top of the well is 204 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift

angles. For the Signal ETS 1 well, which is approximately 1,200 feet deep, Table E2-3 suggests an additional ±105 feet uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: According to the mapping of Hall (1973b), the well spudded in alluvium of Pismo Creek overlying the Monterey Formation or Edna Member of the Pismo Formation near the head of Price Canyon. A fault contact between the Monterey Formation and Edna Member is located within the uncertainty of the well location. Most dips at the surface are moderate to the south-southwest, and the relatively straight fault traces suggest moderately to steeply dipping faulting; likely to the south as well.

The e-log for the Signal ETS 1 well matches reasonably well with the e-log of the nearby Mello 2 well (Section E3.4), despite the nearby faults juxtaposing the lithologically distinct Edna Member sandstone/siltstone and Monterey Formation shale. A one-page well summary report lists "hard shell" between 390 feet and 400 feet depth, and "Monterey-soft lt. br. Shale" at 620 feet depth. From the available information it is unclear whether the well is encountering Monterey Formation or Pismo Formation strata or is alternating between them. A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-13.

**Table E3-13. Summary Interpretation of the Signal ETS 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 620 | Monterey Formation and/or Pismo Formation | Hard shell from 390 to 400 ft. | Moderate to High |
| 620 to 1,168 BOH | Monterey Formation, based on E-Log | Soft light brown shale | High to Moderate |

## E3.14 API 07900618, Rock 75

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1965

TOTAL DEPTH: 2,200 ft. (671 m)

ELEVATION, TOP OF WELL: Approx. 317 ft. (97 m)

SOURCE OF DATA: DOGGR files.

AVAILABLE DATA: History file, including core record and well summary report; e-log with some hand notations

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 308 feet. The reported offset between ground surface and top of well is 8.8 feet. Thus, the preferred elevation of the top of the well is 317 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift angles. For the Rock 75 well, which is 2,200 feet deep, Table E2-3 suggests an additional ±190 feet uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: According to the mapping of Hall (1973b), the well spudded in Edna Member of the Pismo Formation near the head of Price Canyon. A fault is located within the uncertainty of the well location that locally juxtaposes sub-units of the Edna Member differentiated by Hall (1973b). Most dips at the surface are moderate to the south-southwest.

The core record, which includes recovered core and sidewall cores, notes sand, bituminous sand, tar sand, and oil sand between 231 and 1,873 feet, with conglomerate between 500 feet and 520 feet and some siltstone interbeds between 1,748 and 2,019 feet depth. Notes for a sidewall core sample at 2,052 feet read, "fragments clay." Handwritten notes on the e-log include 'Base of massive tar sand" at 590 feet and "Monterey" at 2,020 feet. We interpret this record as possibly indicating Monterey Formation below 2,020 feet, or alternatively, Miguelito Member of the Pismo Formation.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-14.

**Table E3-14. Summary Interpretation of the Rock 75 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 1,500 | Pismo Formation, Edna Member | Sand and tar sand | High |
| 1,500 to 2,030 | Pismo Formation, Edna Member | Oil sand with siltstone interbeds | High |
| 2,030 to 2,200 BOH | Monterey Formation or Pismo Formation, Miguelito Member | Siltstone; clay fragments | Moderate |

## E3.15 API 07900654, Holmes 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1943

TOTAL DEPTH: 3,935 ft. (1,200 m)

ELEVATION, TOP OF WELL: Approx. 103 ft. (31 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: History file with core log, unit designations, and summary paleontology table; e-log with some handwritten notes

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 98 feet. The estimated offset between ground surface and top of well is 5 feet. Thus, the preferred elevation of the top of the well is 103 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

STRATIGRAPHY: According to the mapping of Hall (1973b), the well spudded in the Miguelito Member of the Pismo Formation directly adjacent to the intra-formational contact with the Edna Member, in Price Canyon. The well is located south of the mapped axial trace of the Pismo syncline, in an area of intermediate dips to the northeast. The unconformable contact between the Pismo Formation and underlying Monterey Formation is located approximately 2,700 feet south-southwest of the well.

The well log shows hard silty, somewhat siliceous shale in the upper 1,250 feet, then gray-brown, hard, massive, siliceous silty shale below 1,250 ft, consistent with the Miguelito Member of Hall (1973b). The abundant fossils are all noted to indicate "lower Pismo (i.e., Sisquoc)." At 2,100 feet depth, the well log declares top of Monterey Formation based on "Slumberger and change in type of foraminifera." From 2,100 feet to approximately 2,500 feet, the core is described as siltstone with tar, and below 2,500 feet to the bottom of the hole the descriptions are predominantly of cherty shale.

A summary table of stratigraphic interpretations from the Holmes 1 well is provided in the history file. The table reports "Pismo" between 0 and 2,100 feet depth with no benthic foraminifer zone call. Below Pismo, in order, are "Arenaceous Z. (Delmontian), 2,100 ft. to 2,500 ft., Cherty Z. (U. Mohnian), 2,500 ft. to 3,020 ft., Bent. Brn. (L. Mohnian), 3,020 ft. to 3,540 ft., and finally Buff & Brn. (L. Mohnian), 3,540 ft. to 3,935 ft." The clear implication is that the stratigraphic scheme for the Arroyo Grande area is that the Monterey Formation spans the Luisian, Mohnian, and into the Delmontian benthic foraminifera zones, and that the Pismo Formation is Delmontian or younger. This is apparently in conflict with the mapped Monterey-Pismo Formation contact near Point Buchon, which has been dated to approximately 10 Ma, within the Mohnian benthic foraminifer zone. Thus, we suggest that the uncertainty in the location of the Pismo-Monterey contact is between the 2,100 feet depth, consistent with the well report, and perhaps the 2,500 feet depth boundary between the upper two zones of the Monterey interpreted from the well stratigraphy.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-15.

**Table E3-15. Summary Interpretation of the Holmes 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 2,100 | Pismo Formation, Miguelito Member | Silty shale, with fish and foraminifera | High |
| 2,100 to 3,935 BOH | Monterey Formation (or Miguelito Member to 2,500 ft.) | Silty shale to 2,500 ft., then cherty shale | Moderate to High |

## E3.16 API 07900671, Tar Springs 1A

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1965

TOTAL DEPTH: 3,744 ft. (1,141 m)

ELEVATION, TOP OF WELL: Approx. 1,120 ft. (341 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: History file with core record and well summary report; sonic log; e-log

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 1,115 feet. The estimated offset between ground surface and top of well is 5 feet. Thus, the preferred elevation of the top of the well is 1,120 feet. The reported elevation for the top of the well is "1,025±" feet, suggesting additional uncertainty in the well location. Thus, the uncertainty in this well location is estimated to be ±600 feet (180 m). The uncertainty in elevation is estimated to be ±100 feet (33 m).

STRATIGRAPHY: Easternmost of the wells studied, this 3,744-foot-deep well is primarily in the Monterey Formation. It provides a good picture of the variability of this formation with depth. The well was drilled by Shell Oil Company in 1965, and proved unproductive for oil and gas. The surface is mapped as Santa Margarita sandstone, but at 350 feet where the sonic log begins, the well is interpreted to be in Monterey Formation. The core log describes dark brown shale, massive to laminated throughout. Dips range from 40 to 60 degrees, steepening to 80 to 90 degrees below 4,280 feet. Fracturing and slickensides are described from 3,300 to 3,700 feet.

There were a number of other wells drilled in the Tar Springs area near Huasna Creek. The deepest was 079-00670, drilled to 10,000 feet in 1954. The well notes the base of the Santa Margarita Sand at 520 feet, the top of the middle Miocene at 7,100 feet, and the top of the lower Miocene at 7,570 feet.

The extreme thickness of the Monterey Formation (>5,000 ft.) in this area may be partly due to a high true thickness, and partly due to the steep dips of the bedding resulting in a greater apparent thickness penetrated by the well.

Core samples below 2,950 feet are described as badly fractured with cross-hatched pattern. Many of the fractures are healed, but the core breaks easily. The many fractures may account for the variability in the dip log at these depths.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-16.

**Table E3-16. Summary Interpretation of the Tar Springs 1A Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 350 | Santa Margarita sandstone (basal contact not logged) | Sandstone | High |
| 350 to 3,744 BOH | Monterey Formation | Shale, hard, siliceous in places | Moderate to high |

## E3.17 API 07920532, Leroy F-7B

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1981

TOTAL DEPTH: 7,310 ft. (2,229 m)

ELEVATION, TOP OF WELL: Approx. 100 ft. (30 m)

SOURCES OF DATA: DOGGR files and TGS-NOPEC

AVAILABLE DATA: History file, including deviation log; sonic log for the lowest section; dipmeter logs (incomplete); injection records

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 95 feet. The estimated offset between ground surface and top of well is 5 feet. Thus, the preferred elevation of the top of the well is 100 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

STRATIGRAPHY: Leroy F-7B is one of the deepest wells in the area at a total of 7,310 feet. Located in the Guadalupe Oil field near Point Sal in northern Santa Barbara County, this well penetrates a thick section of Tertiary sediments and the Cretaceous Knoxville Formation. It may have hit Franciscan Complex basement at the bottom. The initial application to drill the well stated that the well was expected to terminate in volcanic pillow basalt at 7,000 feet, presumably of the Point Sal ophiolite, but no record was found indicating whether basement was reached.

No mudlog or lithologic unit data were available. The history file shows that an injection test in the Knoxville Formation was performed. The top of the Knoxville Formation is given to be 2,560 feet, and injection tests in intervals from approximately 3,300 to 6,300 feet in the Knoxville Formation are recorded. The lowest section, the only section for which we have a sonic log, was not tested. We assume this is also in the Knoxville Formation. Summary information for the Leroy F-7B well is provided in Table E3-17.

**Table E3-17. Summary Interpretation of the Leroy F-7B Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 2,560 | ND | ND | ND |
| 2,560 to 7,310 BOH | Knoxville Formation | ND | Moderate |

## E3.18 API 07920544, Guidetti A1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1982

TOTAL DEPTH: 3,050 ft. (930 m)

ELEVATION, TOP OF WELL: Approx. 576 ft. (176 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: Mud log; dip log

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 571 feet. The estimated offset between ground surface and top of well is 5 feet. Thus, the preferred elevation of the top of the well is 576 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

This well is the first of a series of wells drilled in the 1980s in the western part of the Arroyo Grande oil field. This well is located on the south side of the Indian Knob fault, similar to Guidetti A4.

STRATIGRAPHY: According to the geologic map by Hall (1973b), the well spudded in Edna Member of the Pismo Formation near a series of folds adjacent to the Indian Knob fault. The mud log shows an abrupt change from predominantly sandstone to cherty siltstone, shale, and minor limestone at 1,750 feet. The introduction of volcanics in the strata at approximately 2,870 feet and extending to the bottom of the hole mark the contact with Obispo Formation. The summary interpretation of the Guidetti A1 well is in Table E3-18.

**Table E3-18. Summary Interpretation of the Guidetti A1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 1,750 | Pismo Formation, mostly Edna Member | Sandstone | High |
| 1,750 to 2,870 | Monterey Formation | Cherty siltstone and shale | High to moderate |
| 2,870 to 3,050 BOH | Obispo Formation | Volcanics, sand, silt, clay | High |

## E3.19 API 07920545, Guidetti A3

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1982

Total depth: 3,050 ft. (930 m)

ELEVATION, TOP OF WELL: Approx. 367 ft. (112 m)

SOURCES OF DATA: DOGGR files and TGS-NOPEC

AVAILABLE DATA: History file with sidewall core analysis log; mud log; sonic log; dip log; induction log

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 354 feet. The reported offset between ground surface and top of well is 13 feet. Thus, the preferred elevation of the top of the well is 367 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±20 feet (6 m).

This well is one of a series of wells drilled in the 1980s in the western part of the Arroyo Grande oil field. This well is located on the north side of the Indian Knob fault, similar to Guidetti A7.

STRATIGRAPHY: According to the geologic map by Hall (1973b), the well spudded in Edna Member of the Pismo Formation on the north side of the Indian Knob fault. From the mud log, the top of the Monterey Formation is probably between 1,550 feet at the uppermost occurrence of diatomaceous siltstone, and 1,650 feet where the log notes "Possible top of Monterey Shale." The well summary record notes the top of Monterey Formation at 1,640 feet (500 m). Volcanics, presumably of the Obispo Formation are encountered at 2,050 feet (625 m) and extend to the bottom of the hole at 3,050 feet (930 m).

Assuming the volcanics belong to the Obispo, the thickness of the Monterey Formation in this well is 650 feet (2,200 minus 1,550 ft.), to 410 feet (2,050 minus 1,640 ft.). This seems too thin. Faulting may have truncated the Monterey Formation. The change in dip direction at 1,860 feet within the Monterey Formation may be an indicator of a fault. Alternative interpretations for a thinner-than-expected Monterey Formation include deep erosion into the Monterey Formation by the overlying Pismo Formation, or if the volcanics are within the Monterey Formation. A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-19.

**Table E3-19. Summary Interpretation of the Guidetti A3 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 1,640 | Pismo Formation, Edna Member | Sandstone and siltstone | High |
| 1,640 to 2,050 | Monterey Formation | Siltstone, siliceous shale, diatomaceous siltstone | Moderate |
| 2,050 to 3,050 | Obispo Formation | Volcanics and sand | Moderate to High |

## E3.20 API 07920547, Guidetti A7

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1982

TOTAL DEPTH: 2,751 ft. (839 m)

ELEVATION, TOP OF WELL: Approx. 666 ft. (203 m)

SOURCE OF DATA: DOGGR files

AVAILABLE DATA: History file with well summary report and lithologic log; sidewall core log; mud log

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 646 feet. The reported offset between ground surface and top of well is 20 feet. Thus, the preferred elevation of the top of the well is 666 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±20 feet (6 m).

This well is one of a series of wells drilled in the 1980s in the western part of the Arroyo Grande oil field. This well is located on the north side of the Indian Knob fault, similar to Guidetti A3.

STRATIGRAPHY: According to the geologic map by Hall (1973b), the well spudded in Edna Member of the Pismo Formation on the north side of an anticline trending subparallel to the Indian Knob fault. From the mud log, the top of the Monterey Formation is approximately 1,475 feet deep at the transition from mostly sandstone to cherty siltstone and shale. The top of the Obispo Formation is probably at approximately 2,270 feet depth with the sudden presence of volcanics. A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-20.

**Table E3-20. Summary Interpretation of the Guidetti A7 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 1,475 | Pismo (Edna) Formation | Sandstone | High |
| 1,475 to 2,270 | Monterey Formation | Cherty siltstone and shale | High |
| 2,268 to 2,751 BOH | Obispo Formation | Volcanics and shale | Moderate to high |

## E2.21 API 07920566, Guidetti A4

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1983

TOTAL DEPTH: 3,000 ft. (914 m)

ELEVATION, TOP OF WELL: Approx. 266 ft. (81 m)

SOURCES OF DATA: DOGGR files and TGS-NOPEC

AVAILABLE DATA: Mud log; sonic log; dip log; induction log

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 253 feet. The reported offset between ground surface and top of well is 13 feet. Thus, the preferred elevation of the top of the well is 266 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±20 feet (6 m).

This well is one of a series of wells drilled in the 1980s in the western part of the Arroyo Grande oil field. This well is located on the south side of the Indian Knob fault, similar to Guidetti A1.

STRATIGRAPHY: According to the geologic map by Hall (1973b), the well spudded in thin Quaternary alluvium overlying Edna Member of the Pismo Formation within a south-dipping dip panel with intermediate dips. The Miguelito Member is mapped north of the well and directly on the south side of the Indian Knob fault.

Based on the mud log, the upper 500 feet (152 m) is sandstone, presumably of the Edna Member of the Pismo Formation. From 500 to 1,320 feet, lithology changes to siltstone that probably belongs to the Miguelito Member of the Pismo Formation. The Pismo/Monterey Formation contact is placed at approximately 1,320 feet (402 m), based on the first appearance of significant chert. This contact may be an unconformity based on the change in dip and dip direction at the contact.

There is evidence for a fault at 2,096 feet, where a mylonite zone with slickensides is logged in the core. The consistent 30- to 40-degree south dips in the Monterey Formation change abruptly at this depth to approximately 60 degrees southeast, then at 2,700 feet they shallow and change direction again to 20–30 degrees southwest.

The presence of a fault could account for the anomalously thick section of Monterey Formation here. Cross section B-B′ of Hall (1973b) shows the Indian Knob fault cutting through here in a way that thickens the Monterey Formation. If the mylonite zone is the Indian Knob fault, the fault dips south-southwest approximately 55 degrees.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-21.

**Table E3-21. Summary Interpretation of the Guidetti A4 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 500 | Pismo Formation, Edna Member | Sandstone | High |
| 500 to 1,320 | Pismo Formation, Miguelito Member | Siltstone | High to moderate |
| 1,320 to 2,096 | Monterey Formation | Chert and siltstone | Moderate to high |
| 2,096 | FAULT? | Mylonite | Moderate |
| 2,096 to 2,961 | Monterey Formation | Cherty, dolomitic siltstone | High |

## E3.22 API 07920594, Shell Beach 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1984

TOTAL DEPTH: 5,547 ft. (1,690 m)

ELEVATION, TOP OF WELL: Approx. 194 ft. (59 m)

SOURCES OF DATA: DOGGR files and TGS-NOPEC

AVAILABLE DATA: History file; mud log; sonic log; e-log; dip log

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 184 feet. The reported offset between ground surface and top of well is 10.5 feet. Thus, the preferred elevation of the top of the well is 194 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±25 feet (8 m).

STRATIGRAPHY: According to the geologic map by Hall (1973b), the well spudded in Obispo Formation among a series of approximately east-west-trending folds within the southern limb of the Pismo syncline. Drilled along the shoreline near Shell Beach, this well extended 5,547 feet (1,690 m) through a thick section of the Obispo Formation. A newspaper article in the history file states that the drillers were trying to reach the Vaqueros sandstone.

The newspaper article also states that the well was drilled straight down to 1,000 feet, then angled 20 degrees to 2,500 feet, then down again to the bottom. This was done to drill underneath the adjacent hill to the north. The dip log has a more detailed picture of the azimuth and exact angle of the hole at 100-foot intervals. Analysis of the dip log shows the bottom of the well to be located approximately 940 feet north of the top of the well.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-22.

**Table E3-22. Summary Interpretation of the Shell Beach 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 880 | Obispo Formation, fine-grained member | Shale, sandstone, and siltstone with trace volcanic grains | High |
| 880 to 3,000 | Obispo Formation | Volcanics with interbedded siltstone | High |
| 3,000 to 5,250 | Obispo Formation, fine-grained member, resistant member, and possibly intrusive diabase member and/or including Rincon Formation | Sandstone, claystone, and siltstone with glauconite and traces of volcanics<br>Igneous rock (dike?), 70 ft. thick, at 4,000 ft. | Moderate |
| 5,250 to 5,547 BOH | Obispo Formation? | Sandstone, glauconitic, with traces of volcanic fragments | Low |

## E3.23 API 07921166, Rock 11G

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 2008

TOTAL DEPTH: 2,005 ft. (611 m)

ELEVATION, TOP OF WELL: Approx. 210 ft. (64 m)

SOURCES OF DATA: DOGGR files and TGS-NOPEC

AVAILABLE DATA: Sidewall core analysis; sonic log; e-log

LOCATION: The location provided in the DOGGR file was accepted for this project. The LiDAR-based elevation from the project DEM for the preferred location is 200 feet. The reported offset between ground surface and top of well is 10 feet. Thus, the preferred elevation of the top of the well is 210 feet. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m).

There is additional uncertainty in well location due to an uncertain amount and direction of well drift, or deviation from vertical. Table E2-3 contains a summary matrix showing scenario horizontal changes from the bottom of hole to the top for various well depths and average drift angles. For the Rock 11G well, which is approximately 2,000 feet deep, Table E2-3 suggests an additional ±175 feet uncertainty in the location at the bottom of the well given a 5-degree average drift angle. This uncertainty should be considered during analysis of seismic-reflection profiles in the vicinity of the well.

STRATIGRAPHY: According to the mapping of Hall (1973b), the well spudded in shallow Quaternary alluvium of Pismo Creek overlying the Edna Member of the Pismo Formation in Price Canyon.

Sonic log data were collected from 60 to 1,940 feet (18 to 592 m). There is no mud log or lithologic log among the available files, but sidewall core analyses show sand and silty sand throughout the well, with some mudstone below 1,650 feet. We interpret this record as the Edna Member of the Pismo Formation for the entire length of the well.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-23.

**Table E3-23. Summary Interpretation of the Rock 11G Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 2,005 BOH | Pismo Formation, Edna Member | Sandstone | High |

## E3.24 API 560452001300, Offshore Well P-0435-1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1983

TOTAL DEPTH: 6,900 ft. (2,103 m)

ELEVATION, TOP OF WELL: Approximately 35 ft.

SOURCE OF DATA: Willingham et al. (2013)

AVAILABLE DATA: Gamma ray, resistivity, and sonic logs; identification of reflectors; partial mud log

LOCATION: The well location was taken from the ArcGIS shapefile data of offshore Santa Maria basin wells developed by Fugro (Ventura office), the database used by Willingham et al. (2013). The estimated elevation of the top of the well is based on the information for the P-060-1 “Oceano” well provided by Hall (1982).

STRATIGRAPHY: This well is located on the west side of the Hosgri fault zone. Note that the depth to basement is significantly greater than for P-0397-1, located on the east side of the Hosgri fault zone. Willingham et al. (2013) estimate over 850 m of basement displacement across the fault zone in this area. Table E3-24 shows a summary of depths to the tops of major unconformities and formations and a qualitative estimate of confidence in these boundaries. See Figure E2-12 for stratigraphic markers plotted on the sonic log.

**Table 3-24. Summary Interpretation of the Offshore P-0435-1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 1,300 | Top of Miocene unconformity | ND | High |
| 4,300 | Top of Monterey Formation | ND | High |
| 6,300 | Knoxville Formation | ND | High |
| 6,600 | Franciscan Formation | ND | High |

## E3.25 API 560462000100, Offshore Well P-060-1, Oceano 1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1965

TOTAL DEPTH: 8,020 ft. (2,445 m)

ELEVATION, TOP OF WELL: 35 ft.

SOURCES OF DATA: Hall (1982), McCulloch (1987), Miller and Meltzer (1999)

LOCATION: The well location was taken from the ArcGIS shapefile data of offshore Santa Maria basin wells developed by Fugro (Ventura office), the database used by Willingham et al. (2013). The estimated elevation of the top of the well (Kelly bushing) is based on the information in Hall (1982).

STRATIGRAPHY: Table E3-25 shows the interpreted depth intervals and formations and the lithology summaries as provided by Hall (1982) and as consistent with information provided in Figure 2 of Miller and Meltzer (1999) and Figure 9 of McCulloch (1987). The interpretation by Hall (1982) was adopted as the most complete. A qualitative measure of confidence in the interpretations is also provided.

**Table E3-25. Summary Interpretation of the Offshore P-060-1, Oceano 1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 1,220 | Not logged | ND | ND |
| 1,220 to 1,300 | Pliocene? | ND | Low to moderate |
| 1,300 to 3,402 | Foxen Mudstone | Siltstone, sandstone | High |
| 3,402 to 5,484 | Sisquoc Formation | Shale | High |
| 5,484 to 6,660 | Monterey Formation | Siliceous shale, chert, limestone | High |
| 6,660 to 7,060 | Obispo Formation | Volcanic tuff, ash, flows, and sand | High |

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 7,060 to 8,020 BOH | KJf, or Jo, or Tl | Volcanics, shale | Moderate to high |

## E3.26 API 560462000500, Offshore Well P-0397-1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: No

YEAR DRILLED: 1983

TOTAL DEPTH: 3,666 ft. (1,117 m)

ELEVATION, TOP OF WELL: Approximately 35 ft.

SOURCE OF DATA: Willingham et al. (2013)

AVAILABLE DATA: Gamma ray, resistivity, and sonic logs; identification of reflectors; partial mud log

LOCATION: The well location was taken from the ArcGIS shapefile data of offshore Santa Maria basin wells developed by Fugro (Ventura office), the database used by Willingham et al. (2013). The estimated elevation of the top of the well is based on the information for the P-060-1 "Oceano" well provided by Hall (1982).

STRATIGRAPHY: This well is located on the east side of the Hosgri fault zone. Note that the depth to basement is significantly less than for P-0435-1, located on the west side of the Hosgri fault zone. Willingham et al. (2013) estimate over 850 m of basement displacement across the fault zone in this area. Table E3-26 shows a summary of depths to the tops of major unconformities and formations and a qualitative assessment of confidence in the interpretations of Willingham et al. (2013). See Figure E2-12 for stratigraphic markers plotted on the sonic log.

**Table E3-26. Summary Interpretation of the Offshore P-0397-1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 1,050 | Top of Pliocene unconformity | ND | High |
| 1,350 | Top of Miocene unconformity | ND | High |
| 2,350 | Top of Monterey Formation | ND | High |
| 2,850 | Top of Obispo Formation | ND | High |
| 3,200 | Top of Franciscan Formation | ND | High |

## E3.27 30S/10E-13L4, CCW Pecho

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1977

TOTAL DEPTH: 675 ft. (206 m)

ELEVATION, TOP OF WELL: Approx. 71 ft. (22 m)

SOURCE OF DATA: Cleath & Associates (2003)

AVAILABLE DATA: California DWR well driller's report; e-log; sample log

LOCATION: The location digitized from the Cleath & Associates (2003) compilation report was used for this project. The LiDAR-based elevation from the project DEM for the preferred location is 71 feet, which we use as a proxy for the top of well elevation. This value is close to the 68 feet ground level elevation tabulated in the e-log. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m). Additional uncertainty in the location of the bottom of the well from well drift is estimated to be ±60 feet based on an approximately 5-degree average deviation angle from vertical.

STRATIGRAPHY: According to the GMP geologic map and Lettis and Hall (1994), the well spudded in Quaternary aeolian deposits overlying older Quaternary deposits in the Morro Bay depression. The well is located approximately 4,000 feet (1,200 m) north of the closest mapped exposure of pre-Quaternary deposits (mapped exposures of the Miguelito Member of the Pismo Formation near the Spooner 1 well) (Plate 1 of main report). The location of the Los Osos fault zone is inferred to be between the Morro Bay depression and the pre-Quaternary deposits exposed on the northern flank of the Irish Hills.

The sample log shows well-rounded sand from the surface to 35 feet depth, underlain by a sequence of very fine sandy clay, very fine to medium sand, and gravel to a depth of 675 feet. The gravels are typically described as well rounded, 1/8 inch (in.) to 6 in. with chert, quartz, sandstone, diabase, dacite porphyry, and siliceous rock types noted. The e-log shows a change at approximately 475 to 500 feet depth that coincides with a contact between (mostly) non-marine Paso Robles Formation alluvium "TQpr" overlying marine Careaga Formation "Tca" in interpreted cross section B-B' in the Cleath & Associates (2003) report. Supporting the marine interpretation below 500 feet depth is a 2-foot-thick layer of sapropel, or black, slimy carbonaceous ooze, between gravel layers at 611 to 613 feet depth.

At a depth of 675.5 feet, the drillers hit refusal, with the drag bit in hard gray sandstone noted to be, "very much like Franciscan sandstone." We note the possibility that, with only 0.5 foot of penetration, the rock encountered at 675 feet depth may be a boulder and not in-place basement rock.

We interpret this well to contain thin aeolian sand overlying younger and then older alluvium to approximately 500 feet, very nearshore/beach deposits of probable Tertiary age to 675 feet, then Franciscan Complex graywacke below 675 feet. In Table E3-27 we adopt the stratigraphic call of Pliocene Careaga Formation used by Cleath & Associates (2003) for the marine-affiliated deposits, although we note that these deposits may be facies equivalents to upper Pismo Formation units, including the typically massive sandy Squire Member. We do not adopt the Paso Robles Formation designation for the terrestrial alluvial deposits, preferring the more generic term "older alluvium" of probable Plio-Pleistocene age.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-27.

**Table E3-27. Summary Interpretation of the CCW Pecho Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 35 | Quaternary aeolian deposits | Sand | High |
| 35 to 500 | Younger alluvium overlying older alluvium of Plio-Pleistocene age | Sandy clay, clayey sand, and gravel | High to moderate |
| 500 to 675 | Careaga Formation | Gravel, sand, and clay | High to moderate |
| 675 to 675.5 BOH | Franciscan Complex | Sandstone | High to moderate |

## E3.28 30S/10E-13Na, S&T New

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1999

TOTAL DEPTH: 500 ft. (152 m)

ELEVATION, TOP OF WELL: Approx. 137 ft. (42 m)

SOURCE OF DATA: Cleath & Associates (2003)

AVAILABLE DATA: California DWR well completion report; excerpts from summary report; e-log

LOCATION: The location digitized from the Cleath & Associates (2003) compilation report was used for this project. The LiDAR-based elevation from the project DEM for the preferred location is 137 feet, which we use as a proxy for the top of well elevation. This value is close to the 140 feet elevation tabulated by Cleath & Associates (2003). The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m). Additional uncertainty in the location of the bottom of the well from well drift is estimated to be ±50 feet based on an approximately 5-degree average deviation angle from vertical.

STRATIGRAPHY: According to the GMP geologic map and Lettis and Hall (1994), the well spudded in Quaternary aeolian deposits overlying older Quaternary deposits in the Morro Bay depression. The well is located approximately 2,900 feet (900 m) north of the closest mapped exposure of pre-Quaternary deposits (mapped exposures of the Miguelito Member of the Pismo Formation near the Spooner 1 well) (Plate 1 of main report). The location of the Los Osos fault zone is inferred to be between the Morro Bay depression and the pre-Quaternary deposits exposed on the northern flank of the Irish Hills.

The brief summary report excerpt states that, based on the e-log and drill cuttings, sand is present at the surface to 100 feet depth, sand, gravel, and sandy clay to a depth of 380 feet, and then mostly clay from 380 to 500 feet. Cleath & Associates (2003), on their cross section C-C', interpret dune sand from 0 to 50 feet, then Paso Robles Formation to the bottom of the well.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-28.

**Table E3-28. Summary Interpretation of the S&T New Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to ~50 | Quaternary aeolian deposits | Sand | High |
| ~50 to 500 BOH | Younger alluvium overlying older alluvium of Plio-Pleistocene age | Sand, gravel, and sandy clay | High to moderate |

## E3.29 30S/11E-17E7, LOCSD—SB Deep

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: ND

TOTAL DEPTH: 560 ft. (171 m)

ELEVATION, TOP OF WELL: Approx. 114 ft. (35 m)

SOURCE OF DATA: Cleath & Associates (2003)

AVAILABLE DATA: Lithologic log; e-log

LOCATION: The location digitized from the Cleath & Associates (2003) compilation report was used for this project. The LiDAR-based elevation from the project DEM for the preferred location is 114 feet, which we use as a proxy for the top of well elevation. This value is close to the 106 feet elevation tabulated by Cleath & Associates (2003). The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m). Additional uncertainty in the location of the bottom of the well from well drift is estimated to be ±50 feet based on an approximately 5-degree average deviation angle from vertical.

STRATIGRAPHY: According to the GMP geologic map and Lettis and Hall (1994), the well spudded in Quaternary aeolian deposits overlying older Quaternary deposits in the Morro Bay depression. The well is located approximately 6,000 feet (1,900 m) north of the closest mapped exposure of pre-Quaternary deposits (mapped exposures of the Miguelito Member of the Pismo Formation; Plate 1 of main report). The location of the Los Osos fault zone is inferred to be between the Morro Bay depression and the pre-Quaternary deposits exposed on the northern flank of the Irish Hills.

The lithologic log for the SB deep well includes an interpretation that is consistent with the cross section F-F' in the main Cleath & Associates (2003) report. From 0 to 55 feet, the sub-rounded sand with some fine gravel is interpreted to be aeolian sand. From 55 to 474 feet, the well encountered medium to coarse sand, sandy clay, silty sand, and sand and gravel. This alluvium is subdivided in to upper and lower Paso Robles Formation. From 474 to 518 feet, apparently poorly lithified sandstone with abundant shell fragments and a 6-foot-thick clay interbed is interpreted to be Careaga Formation. From 518 feet to the bottom of the well, marine shale and sandstone is interpreted to be Franciscan Complex.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-29.

**Table E3-29. Summary Interpretation of the LOCSD—SB Deep Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 55 | Quaternary aeolian deposits | Sand | High |
| 55 to 474 | Younger alluvium overlying older alluvium of Plio-Pleistocene age | Sandy clay, silty sand, sand, and gravel | High |
| 474 to 518 | Careaga Formation | Sand(stone) with shell fragments and clay | High to moderate |
| 518 to 560 BOH | Franciscan Complex | Shale and sandstone | High to moderate |

## E3.30 30S/11E-17N10, CCW—SB #1

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 2001

TOTAL DEPTH: 750 ft. (229 m)

ELEVATION, TOP OF WELL: Approx. 150 ft. (46 m)

SOURCE OF DATA: Cleath & Associates (2003)

AVAILABLE DATA: California DWR well completion report; lithologic log; e-log

LOCATION: The location digitized from the Cleath & Associates (2003) compilation report was used for this project. The LiDAR-based elevation from the project DEM for the preferred location is 150 feet, which we use as a proxy for the top of well elevation. This value is close to the 136 feet elevation tabulated by Cleath & Associates (2003), and is equal to the "Approx. 150 ft." elevation noted in the Lithologic log. The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±20 feet (6 m). Additional uncertainty in the location of the bottom of the well from well drift is estimated to be ±60 feet based on an approximately 5-degree average deviation angle from vertical.

STRATIGRAPHY: According to the GMP geologic map and Lettis and Hall (1994), the well spudded in Quaternary aeolian deposits overlying older Quaternary deposits in the Morro Bay depression. The well is located approximately 3,900 feet (1,200 m) north of the closest mapped exposure of pre-Quaternary deposits (mapped exposures of the Miguelito Member of the Pismo Formation; Plate 1 of main report). The location of the Los Osos fault zone is inferred to be between the Morro Bay depression and the pre-Quaternary deposits exposed on the northern flank of the Irish Hills.

The lithologic log was produced by S. Harris of Cleath & Associates who provides his interpretation of the log on cross sections B-B' and F-F' in the Cleath & Associates (2003) report. Sand to a depth of 37 feet is interpreted as aeolian deposits. Alternating layers of clay, gravelly clay, sand and gravel, sandy clay, and sand extend to the bottom of the hole, with a comment about slow drilling and small, angular chips of hard, find-grained sandstone in the last 10 feet. Cleath & Associates (2003) interpret the bottom of the well to be in sandstone, presumably graywacke of the Franciscan Complex, and a contact between Paso Robles and Careaga

Formation at approximately 525 feet. Beneath this depth are thick intervals of fine-grained sand with silty sand and clayey lenses, while above this interval layers of gravelly sand with angular to sub-rounded fine gravel are common.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-30.

**Table E3-30. Summary Interpretation of the CCW—SB #1 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 37 | Quaternary aeolian deposits | Sand | High |
| 37 to 525 | Younger alluvium overlying older alluvium of Plio-Pleistocene age | Sandy clay, clayey sand, and gravelly clay and sand | High |
| 525 to 740 | Careaga Formation | sand, silty sand, clayey sand, and sandy clay | Moderate to high |
| 740 to 750 BOH | Franciscan Complex | Sandstone | Moderate to high |

## E3.31 30S/11E-18F2, LOCSD—Ferrell #2

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1975

TOTAL DEPTH: 645 ft. (197 m)

ELEVATION, TOP OF WELL: Approx. 100 ft. (31 m)

SOURCE OF DATA: Cleath & Associates (2003)

AVAILABLE DATA: California DWR well driller's report; excerpt interpretation log from summary report

LOCATION: The location digitized from the Cleath & Associates (2003) compilation report was used for this project. The LiDAR-based elevation from the project DEM for the preferred location is 100 feet, which we use as a proxy for the top of well elevation. This value is equal to the elevation tabulated by Cleath & Associates (2003). The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m). Additional uncertainty in the location of the bottom of the well from well drift is estimated to be ±60 feet based on an approximately 5-degree average deviation angle from vertical.

STRATIGRAPHY: According to the GMP geologic map and Lettis and Hall (1994), the well spudded in Quaternary aeolian deposits overlying older Quaternary deposits in the Morro Bay depression. The well is located approximately 5,500 feet (1,700 m) north of the closest mapped exposure of pre-Quaternary deposits (mapped exposures of the Miguelito Member of the Pismo Formation; Plate 1 of main report). The location of the Los Osos fault zone is inferred to be

between the Morro Bay depression and the pre-Quaternary deposits exposed on the northern flank of the Irish Hills.

The water well driller's report contains an abbreviated description of materials encountered in the well, and Cleath & Associates (2003) provides an interpretation on cross sections H-H' and I-I' in their report. Sand encountered between 0 and 45 feet is interpreted as aeolian deposits. This is underlain by intervals of clay, sand and gravel, and sandy clay to a depth of 600 feet. From 600 to 610 feet, the log notes "gravel & sea shale (sandy)", which Cleath & Associates (2003) interpret as Careaga Formation. From 610 to 645 feet, the log notes "brown shale" which is interpreted as pre-Careaga Formation, and possibly Franciscan Complex.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-31.

**Table E3-31. Summary Interpretation of the LOCSD—Ferrell #2 Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 45 | Quaternary aeolian deposits | Sand | High |
| 45 to 600 | Younger alluvium overlying older alluvium of Plio-Pleistocene age | Clay, sand and gravel, and sandy clay | High |
| 600 to 610 | Careaga Formation | "gravel and sea shale" | Low to moderate |
| 610 to 645 BOH | Franciscan Complex | Shale | Moderate to low |

## E3.32 30S/11E-18K8, LOCSD—10th New

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: ND

TOTAL DEPTH: Approx. 650 ft. (198 m)

ELEVATION, TOP OF WELL: Approx. 134 ft. (41 m)

SOURCE OF DATA: Cleath & Associates (2003)

AVAILABLE DATA: Lithologic log; e-log with missing header

LOCATION: The location digitized from the Cleath & Associates (2003) compilation report was used for this project. The LiDAR-based elevation from the project DEM for the preferred location is 134 feet, which we use as a proxy for the top of well elevation. This value is close to the 136 feet elevation tabulated by Cleath & Associates (2003). The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m). Additional uncertainty in the location of the bottom of the well from well drift is estimated to be ±60 feet based on an approximately 5-degree average deviation angle from vertical.

STRATIGRAPHY: According to the GMP geologic map and Lettis and Hall (1994), the well spudded in Quaternary aeolian deposits overlying older Quaternary deposits in the Morro Bay

depression. The well is located approximately 4,400 feet (1,300 m) north of the closest mapped exposure of pre-Quaternary deposits (mapped exposures of Miguelito Member, Pismo Formation; Plate 1 of main report). The location of the Los Osos fault zone is inferred to be between the Morro Bay depression and the pre-Quaternary deposits exposed on the northern flank of the Irish Hills.

The lithologic log for the LOCSD—10th new well includes an interpretation that is consistent with the cross section B-B' in the main Cleath & Associates (2003) report. From 0 to 110 feet, the fine to medium sand is interpreted to be aeolian deposits. From 110 to 592 feet, the well encountered sandy clay, sand with gravel, clayey sand, and silty sand. This alluvium is subdivided into upper and lower Paso Robles Formation. From 592 feet to the bottom of the well, fine to medium sand with seashells is interpreted to be Careaga Formation.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-32.

**Table E3-32. Summary Interpretation of the LOCSD—10th New Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 110 | Quaternary aeolian deposits | Sand | High |
| 110 to 592 | Younger alluvium overlying older alluvium of Plio-Pleistocene age | Sandy clay, sand with gravel, clayey sand, and silty sand | High |
| 592 to 650 BOH | Careaga Formation | Sand with seashells | High |

## E3.33 30S/11E-18L2, LOCSD—Palisades

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1981

TOTAL DEPTH: 612 ft. (187 m)

ELEVATION, TOP OF WELL: Approx. 98 ft. (30 m)

SOURCE OF DATA: Cleath & Associates (2003)

AVAILABLE DATA: California DWR well driller's report; e-log with interpretation notes

LOCATION: The location digitized from the Cleath & Associates (2003) compilation report was used for this project. The LiDAR-based elevation from the project DEM for the preferred location is 98 feet, which we use as a proxy for the top of well elevation. This value is close to the 81 feet elevation tabulated by Cleath & Associates (2003). The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±20 feet (6 m). Additional uncertainty in the location of the bottom of the well from well drift is estimated to be ±50 feet based on an approximately 5-degree average deviation angle from vertical.

STRATIGRAPHY: According to the GMP geologic map and Lettis and Hall (1994), the well spudded in Quaternary aeolian deposits overlying older Quaternary deposits in the Morro Bay

depression. The well is located approximately 4,400 feet (1,300 m) north of the closest mapped exposure of pre-Quaternary deposits (mapped exposures of the Miguelito Member of the Pismo Formation; Plate 1 of main report). The location of the Los Osos fault zone is inferred to be between the Morro Bay depression and the pre-Quaternary deposits exposed on the northern flank of the Irish Hills.

The water well driller's report contains brief descriptions of materials encountered, and Cleath & Associates (2003) provide an interpretation on their cross section B-B' in the main report. Sand from 0 to 15 feet is interpreted as aeolian deposits. From 15 to 525 feet depth, the log describes sandy clay, sand, clay, and gravel with sand and clay that is interpreted as Paso Robles Formation. Below 520 feet to the bottom of the well at 612 feet, the log describes fine sand, sandy clay, clay, and sandy brown clay with gravel lenses. The lowest interval includes a description of sand and decomposed rock. The interval between approximately 525 feet to the bottom of the hole is interpreted as Careaga Formation.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-33.

**Table E3-33. Summary Interpretation of the LOCSD—Palisades Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 15 | Quaternary aeolian deposits | Sand | High |
| 15 to 525 | Younger alluvium overlying older alluvium of Plio-Pleistocene age | Sandy clay, sand, clay, and gravel with sand and clay | High |
| 525 to 612 BOH | Careaga Formation | Fine sand, sandy clay, clay, sandy clay with gravel lenses | Moderate |

## E3.34 30S/11E-18L6, USGS—Palisades

ADJACENT TO 2011 SEISMIC-REFLECTION SURVEY: Yes

YEAR DRILLED: 1985

TOTAL DEPTH: 620 ft. (189 m)

ELEVATION, TOP OF WELL: Approx. 79 ft. (24 m)

SOURCE OF DATA: Cleath & Associates (2003)

AVAILABLE DATA: California DWR well driller's report; lithologic log; e-log

LOCATION: The location digitized from the Cleath & Associates (2003) compilation report was used for this project. The LiDAR-based elevation from the project DEM for the preferred location is 79 feet, which we use as a proxy for the top of well elevation. This value is close to the 76 feet elevation noted in the lithologic log compiled by Cleath & Associates (2003). The uncertainty in this well location is estimated to be ±300 feet (100 m). The uncertainty in elevation is estimated to be ±10 feet (3 m). Additional uncertainty in the location of the bottom

of the well from well drift is estimated to be ±50 feet based on an approximately 5-degree average deviation angle from vertical.

STRATIGRAPHY: According to the GMP geologic map and Lettis and Hall (1994), the well spudded in Quaternary aeolian deposits overlying older Quaternary deposits in the Morro Bay depression. The well is located approximately 5,400 feet (1,600 m) north of the closest mapped exposure of pre-Quaternary deposits (mapped exposures of the Miguelito Member of the Pismo Formation; Plate 1 of main report). The location of the Los Osos fault zone is inferred to be between the Morro Bay depression and the pre-Quaternary deposits exposed on the northern flank of the Irish Hills.

The lithologic log for the USGS—Palisades well was interpreted on cross section I-I' in Cleath & Associates (2003). Sand from 0 to 17 feet depth is interpreted as aeolian deposits. Intervals of clay, sandy clay, sand with gravel, silty clay and clay gravel between 17 and 554 feet are interpreted to be Paso Robles Formation. Below 554 feet to the bottom of the well at 620 feet, the log indicates sand with some porcelaneous white shaley chips and shell fragments within sand and gravel. The shaley chips are possibly broken gravels from the Monterey or Pismo Formation (Miguelito Member). This interval is interpreted as Careaga Formation.

A summary of the well interpretation, including a qualitative confidence assessment in a preferred formation contact interpretation, is presented in Table E3-34.

**Table E3-34. Summary Interpretation of the USGS—Palisades Well**

| Depth (ft.) | Formation | Lithology | Confidence |
|---|---|---|---|
| 0 to 17 | Quaternary aeolian deposits | Sand | High |
| 17 to 554 | Younger alluvium overlying older alluvium of Plio-Pleistocene age | Clay, sandy clay, silty clay, sand with gravel, and clay gravel | High |
| 554 to 620 BOH | Careaga Formation | Sand with shale chips and sand and gravel with shell fragments | High to moderate |

## E4.0 VELOCITY CHARACTERISTICS FROM SONIC LOG DATA

Sonic log data were selected and digitized with the purpose of providing information on the geophysical properties of stratigraphic units that are expected to be imaged in the seismic-reflection surveys. Figures E1-1, E2-1, and E2-2 show the locations of the wells with sonic log data compiled for this study. The methods for digitizing the sonic log data are presented in Section E2.5. As mentioned previously, we have not encountered sonic log data for the Honolulu-Tidewater 1 well, although the well history file states that sonic logs were collected in the lower portion of that well.

The digitized sonic logs, presented for 8 wells in Figures E2-9 through E2-12, form the basis for estimating typical velocities and ranges of velocities for specific geologic units. Table E4-1 shows the mean velocity for each unit in each well, and the range within 90 percent of the plot

falls in parentheses. These velocities may be considered to guide the processing of seismic-reflection survey data.

## Table E4-1. Typical P-Wave Velocities from Sonic Log Data

| | | | **Velocity** (x1000 fps), mean (90% range) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Well name** | **Depth (ft)** | **Pliocene** (offshore) | **Pismo Edna Mbr. (ss,** sltstn, sh**)** | **Pismo Miguelito (sh, sltstn,** ss**)** | **Upper Miocene** (offshore) | **Monterey (sh, sltstn, cht)** | **Point Sal (sltstn, ss, sh** | **Obispo (volcanics)** | **Rincon (shale,** ss, sltstn**,** volc**)** | **Knoxville (sandstone)** | **Franciscan** |
| Offshore | P-0397-1 | 800-3400 | 6.0 (5.5-7.0) | | | 9.0 (6.5-11.0) | 11.0 (9.0-12.5) | 11.0 (10.0-12.0) | 10.0 (9.0-12.0) | | | 10.5 (10.0-11.0) |
| | P-0415-1 | 1000-3800** | 6.0 (5.0-7.0) | | | 6.5 (6.0-7.0)** | | | | | | |
| | | 3,800-9,700*** | | | | 8.5 (7.5-9.5)*** | 10.5 (9.0-12.0) | | 12.5 (10.0-15.0) To+Paleogene | | | 12.0 (11.0-14.0) |
| | P-0422-1 | 0-3700** | 5.0 (4.5-5.5) | | | 7.0 (6.5-7.5)** | | | | | | |
| | | 3700-10,000*** | | | | 9.0 (8.5-10.0)*** | 12.0 (9.0-15.0) | | | | | 13.0 (12.0-15.0) |
| | P-0435-1 | 800-3300** | 6.5 (6.0-7.0) | | | 7.0 (6.5-7.5)** | | | | | | |
| | | 3300-6,500*** | | | | 9.5 (8.0-10.5)*** | 12.0 (9.5-15.0)* | | | | 14.0 (12.0-15.0) | 15.0 (14.0-16.5) |
| Onshore | Tar Springs 1A | 300-1300 | | | | | 8.0 (7.0-10.0)* | | | | | |
| | | 1300-2000 | | | | | 11.0 (10.0-12.0)* | | | | | |
| | | 2000-3700 | | | | | 12.5 (11.0-14.0)* | | | | | |
| | Shell Beach | 500-1000 | | | | | | 8.5 (7.0-11.0) | | | | |
| | | 1000-3000 | | | | | | | 8.5 (7.0-11.0) | | | |
| | | 3000-5200 | | | | | | | | 12.0 (8.0-16.0) | | |
| | | 5200-5500 | | | | | | | | | 17.5 (15.0-19.0) | |
| | Rock 11G | 100-2,000 | | 7.0 (6.0-8.0) | | | | | | | | |
| | Leroy F-7B | 6,600-7,200 | | | | | | | | | 15.0 (13.0-16.0) | |
| | Guideti A3 | 600-1,650 | | 6.0 (5.0-8.0) | | | | | | | | |
| | | 1,650-2100 | | | | | 6.5 (5.0-8.0) | | | | | |
| | | 2100-3000 | | | | | | | 9.0 (7.0-12.0) | | | |
| | Guidetti A4 | 600-1,300 | | | 9.5 (7.5-10.5) | | | | | | | |
| | | 1,300-3,000 | | | | | 10.0 (9.0-11.0) | | | | | |

* Velocity increases steadily with depth within the formation.
**Above the Opal CT/Qtz transition
***Below the Opal CT/Qtz transition

Notes:
Velocities are estimated from downhole sonic log depth plots, to the nearest 500 fps.
Offshore well data are from well log plots on Plate 4 of Willingham et al., 2013.
Onshore well data are from sonic logs compiled in the DCPP Historical Wells data report, prepared by Fugro Consultants, Jan 2012.

## E5.0 REFERENCES

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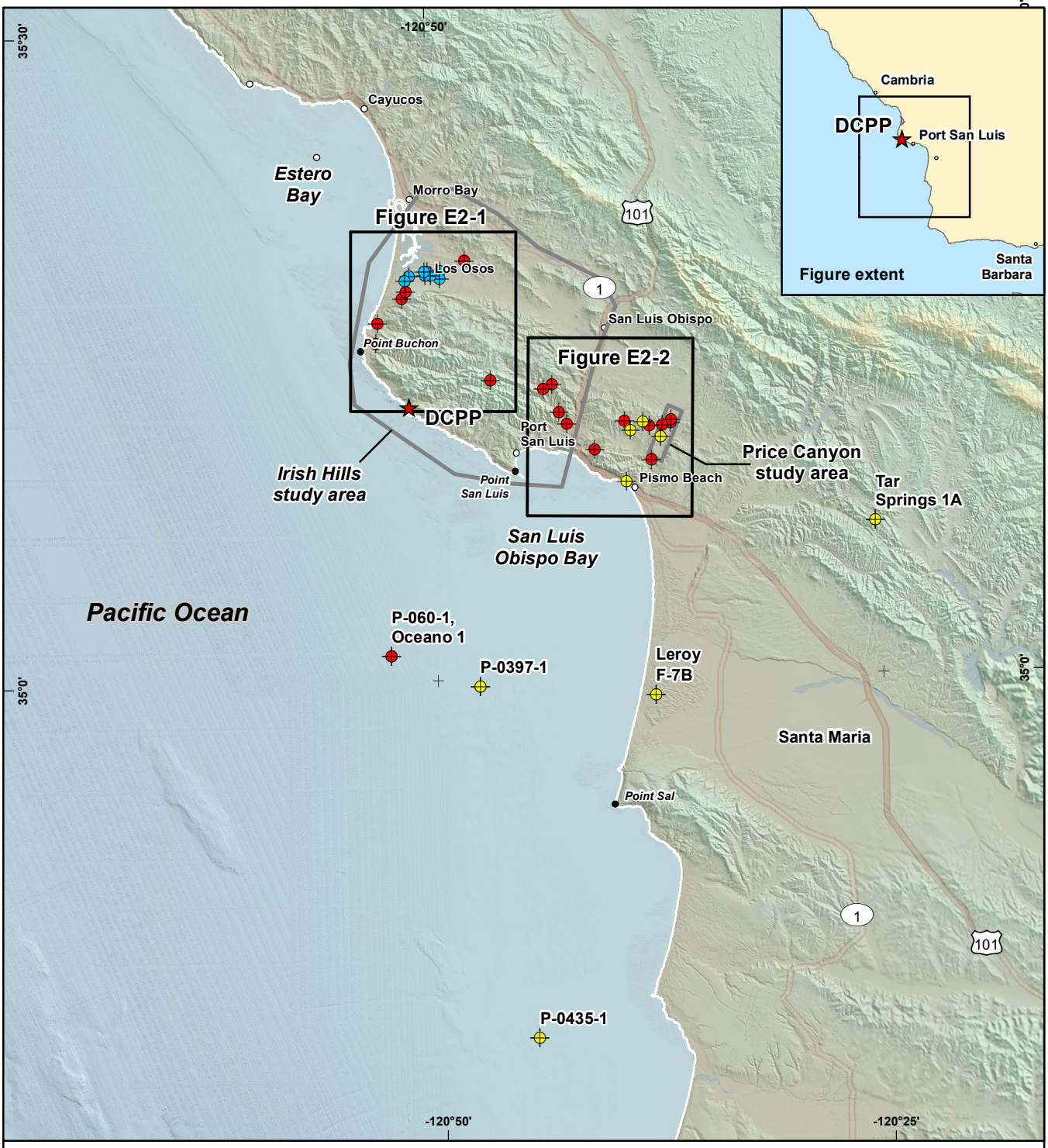


**EXPLANATION**

- Hydrogeologic well
- Oil well
- Oil well with sonic log

N

0 5 10 mi.

0 10 20 km

Map projection and scale: WGS 84 / UTM Zone 10N,1:500,000

## Location of Selected Wells

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **E1-1**

File path: S:\1005\020\QA_GIS\Final_Figures\Figure_E1-01.mxd; Date: 06/03/2014; User: Alex Remar, LCI


**EXPLANATION**

**Wells**

- Hydrogeologic well
- Oil well
- Oil well with sonic log

**Seismic Reflection Survey**

- AWD lines
- Vibroseis lines and nodal receivers

N

0 1 2 mi.

0 2 4 km

Map projection and scale: WGS 84 / UTM Zone 10N,1:80,000

# Location of Selected Wells and 2011 Seismic Reflection Lines Western Irish Hills

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **E2-1**

Ch9.GEO.DCPP.TR.14.01 R0 App E

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**EXPLANATION**

**Wells**

- Hydrogeologic well
- Oil well
- Oil well with sonic log

**Seismic Reflection Survey**

- AWD lines

N

0 1 2 mi.

0 2 4 km

Map projection and scale: WGS 84 / UTM Zone 10N,1:80,000

# Location of Selected Oil Wells and 2011 Seismic Reflection Lines Eastern Irish Hills and San Luis Range

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **E2-2**

Ch9.GEO.DCPP.TR.14.01 R0 App E

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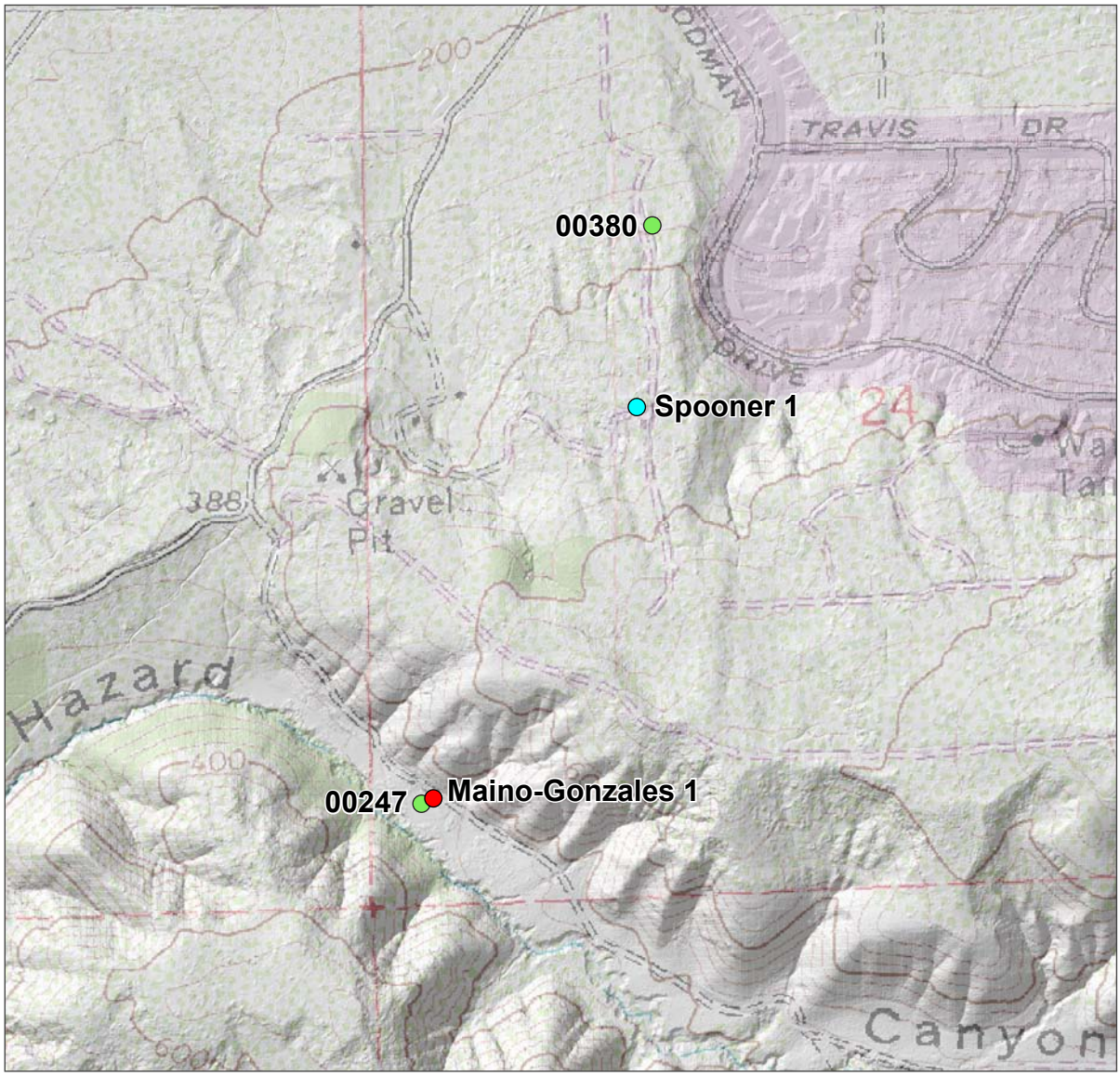


Base map: LiDAR-derived hillshade overlain by USGS topographic quadrangle map

**EXPLANATION**

**00247** DOGGR database

ArcGIS plot of well record (preferred)

Field location, 2013 (preferred)

N

0 500 1,000 ft.

0 250 500 m

# Location of the Maino-Gonzales 1 and Spooner 1 Wells

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **E2-3**

Ch9.GEO.DCPP.TR.14.01 R0 App E

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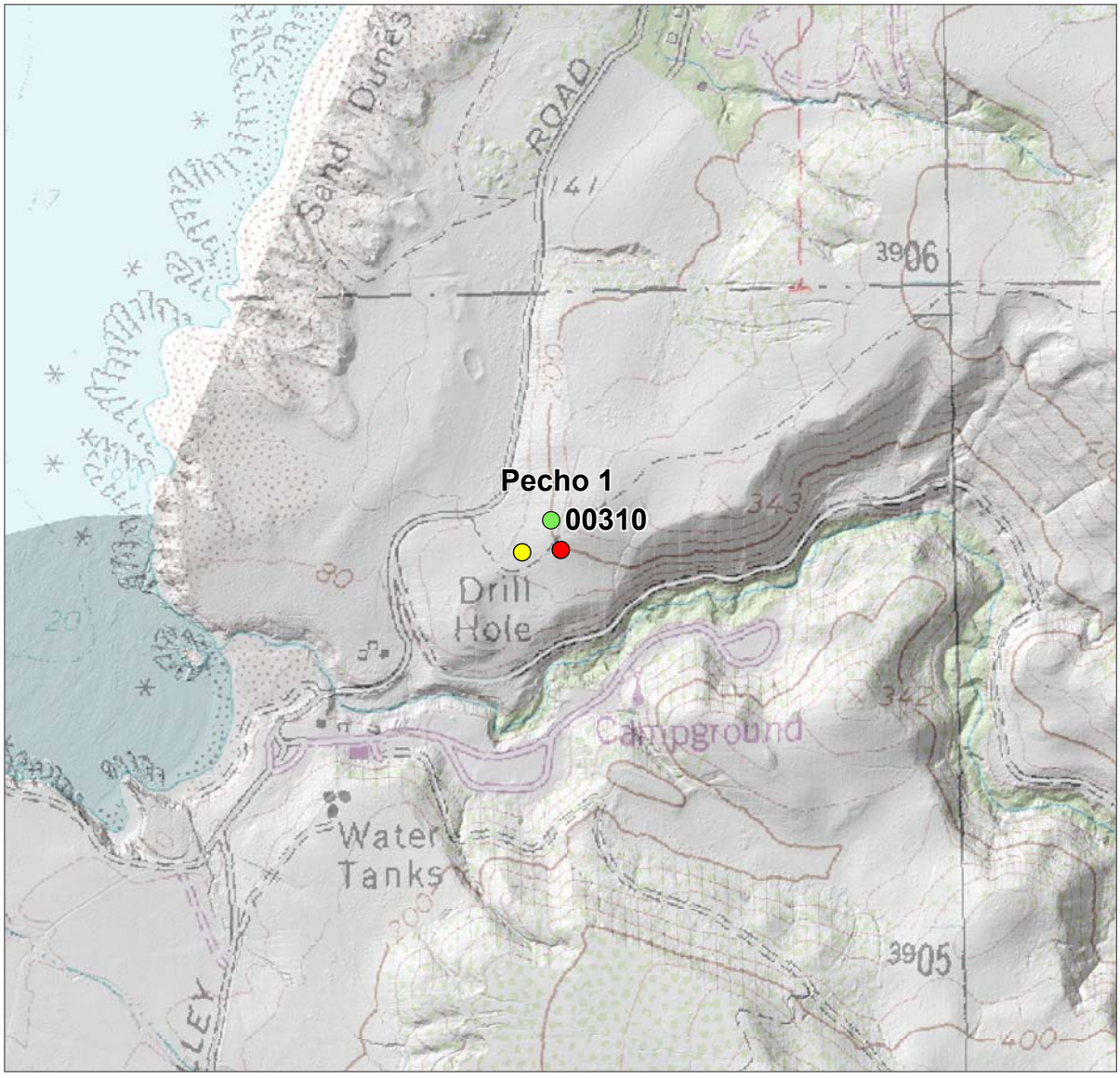


Base map: LiDAR-derived hillshade overlain by USGS topographic quadrangle map

**EXPLANATION**

**00310** DOGGR database

ArcGIS plot of well record

Location of "Drill Hole" from USGS (preferred)

N

0 500 1,000 ft.

0 250 500 m

## Location of the Pecho 1 Well

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **E2-4**

Ch9.GEO.DCPP.TR.14.01 R0 App E

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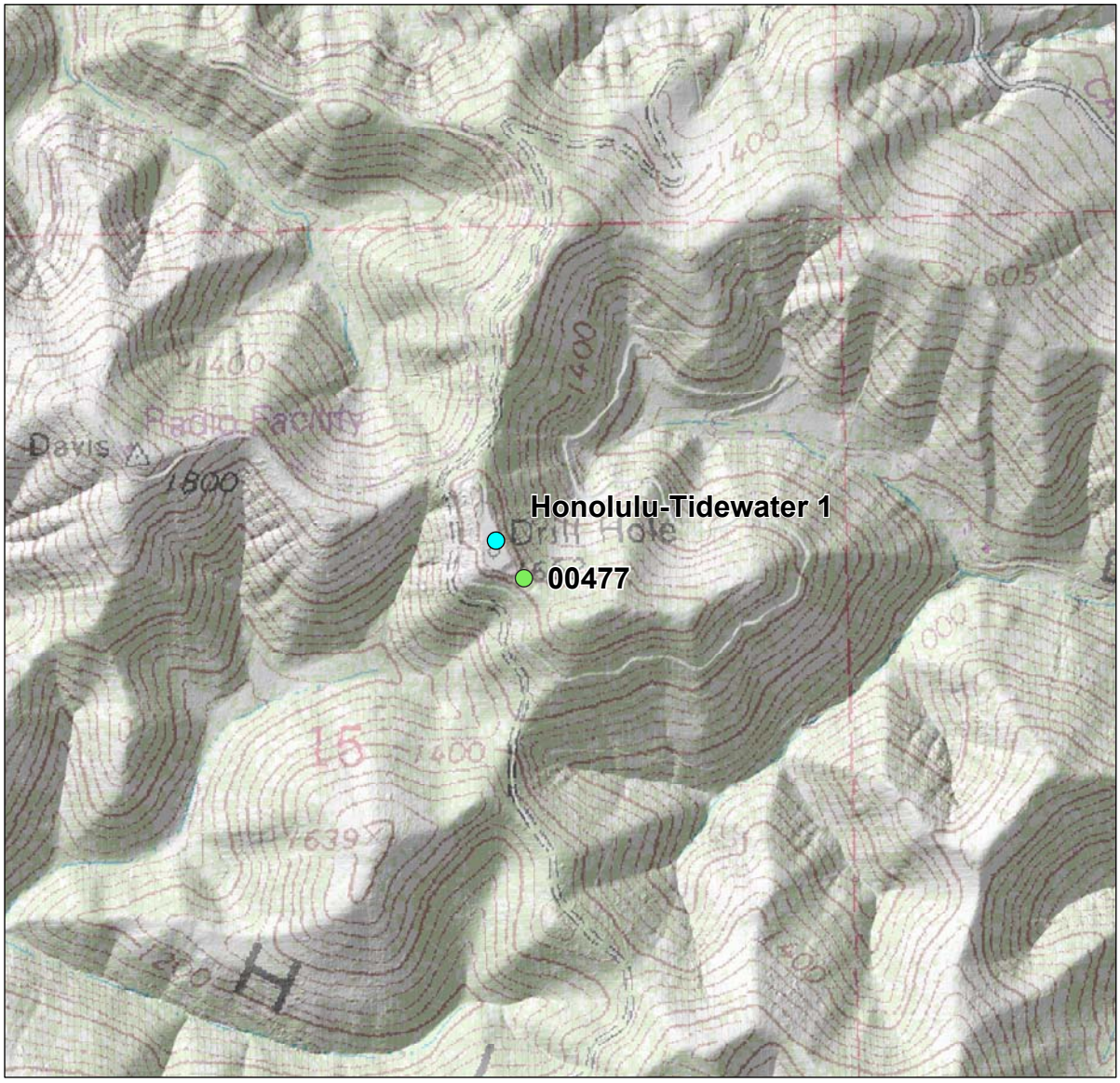


Base map: LiDAR-derived hillshade overlain by USGS topographic quadrangle map

**EXPLANATION**

**00477** DOGGR database

Field location, 2012 (preferred)

N

0 500 1,000 ft.

0 250 500 m

**Location of the Honolulu-Tidewater 1 Well**

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **E2-5**

Ch9.GEO.DCPP.TR.14.01 R0 App E

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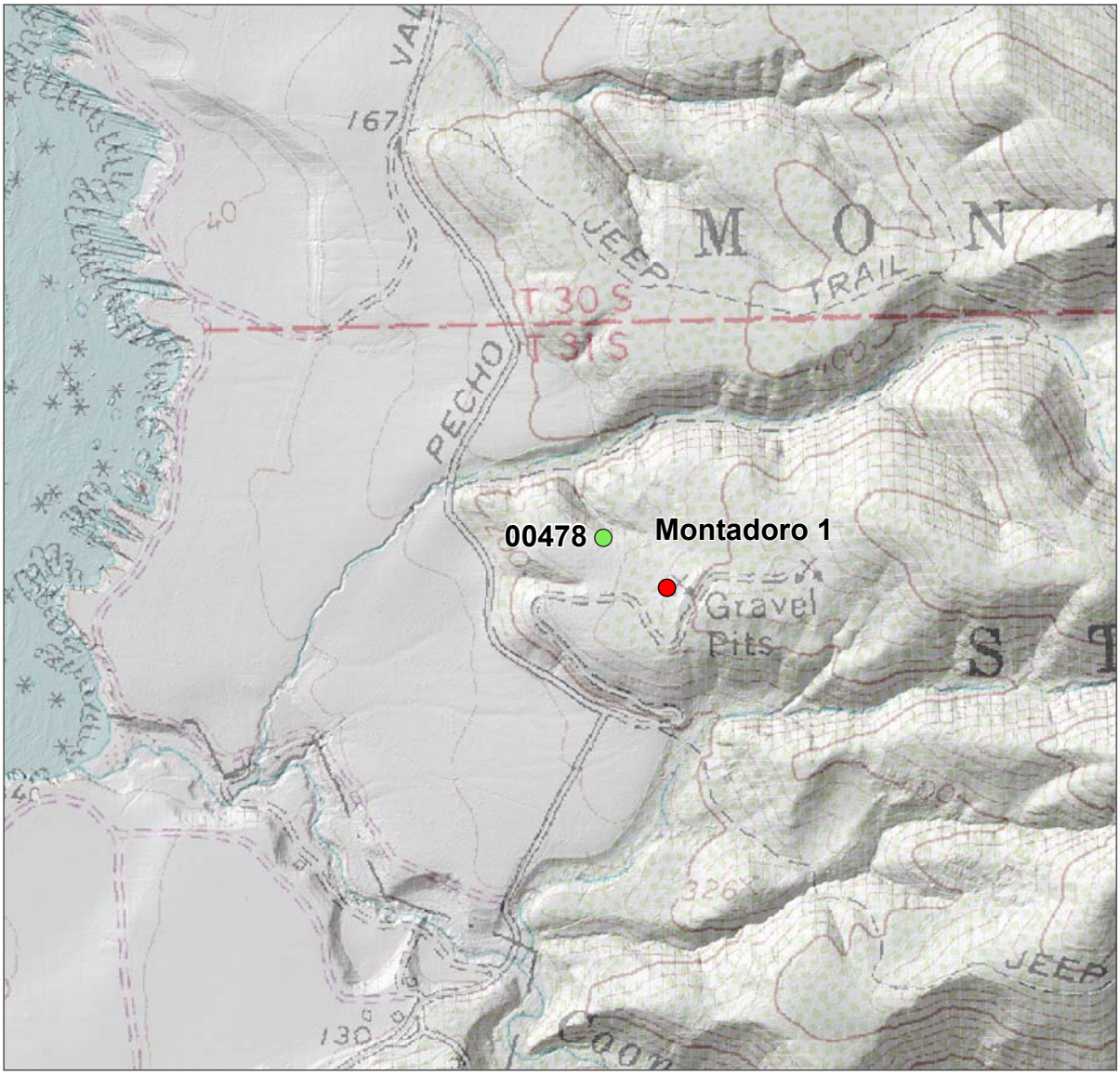


Base map: LiDAR-derived hillshade overlain by USGS topographic quadrangle map

**EXPLANATION**

**00478** DOGGR database

ArcGIS plot of well record (preferred)

N

0 500 1,000 ft.

0 250 500 m

## Location of the Montadoro 1 Well

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **E2-6**

Ch9.GEO.DCPP.TR.14.01 R0 App E

File Path: S:\1005\020\QA_GIS\Final_Figures\Figure_E2-06.ai; Date: 05/29/2014; User: Alex Remar


Base map: LiDAR-derived hillshade overlain by USGS topographic quadrangle map

**EXPLANATION**

**00581** DOGGR database

ArcGIS plot of well record (preferred)

N

0 500 1,000 ft

0 250 500 m

## Location of the Sousa 1 Well

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company

Figure **E2-7**

Ch9.GEO.DCPP.TR.14.01 R0 App E

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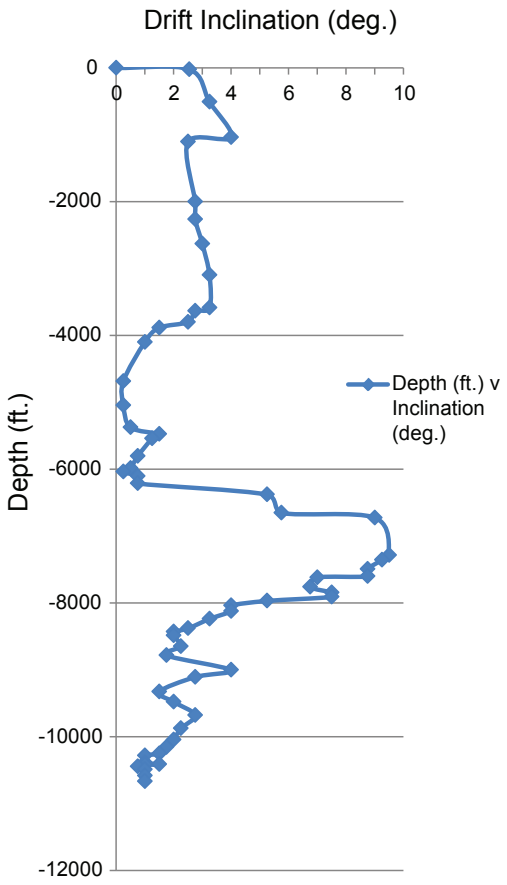
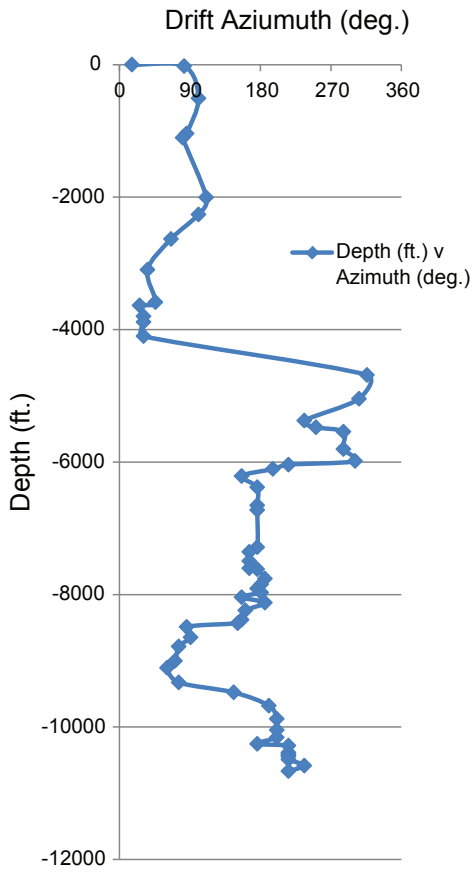
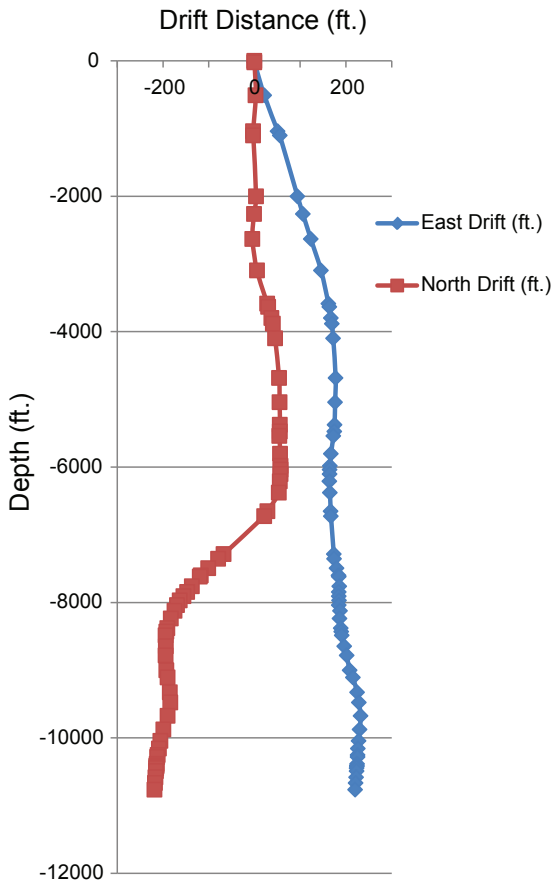
**(a) Depth vs. Inclination**




**(b) Depth vs. Azimuth**




**(c) Depth vs. Drift Distance (Easting and Northing Components)**

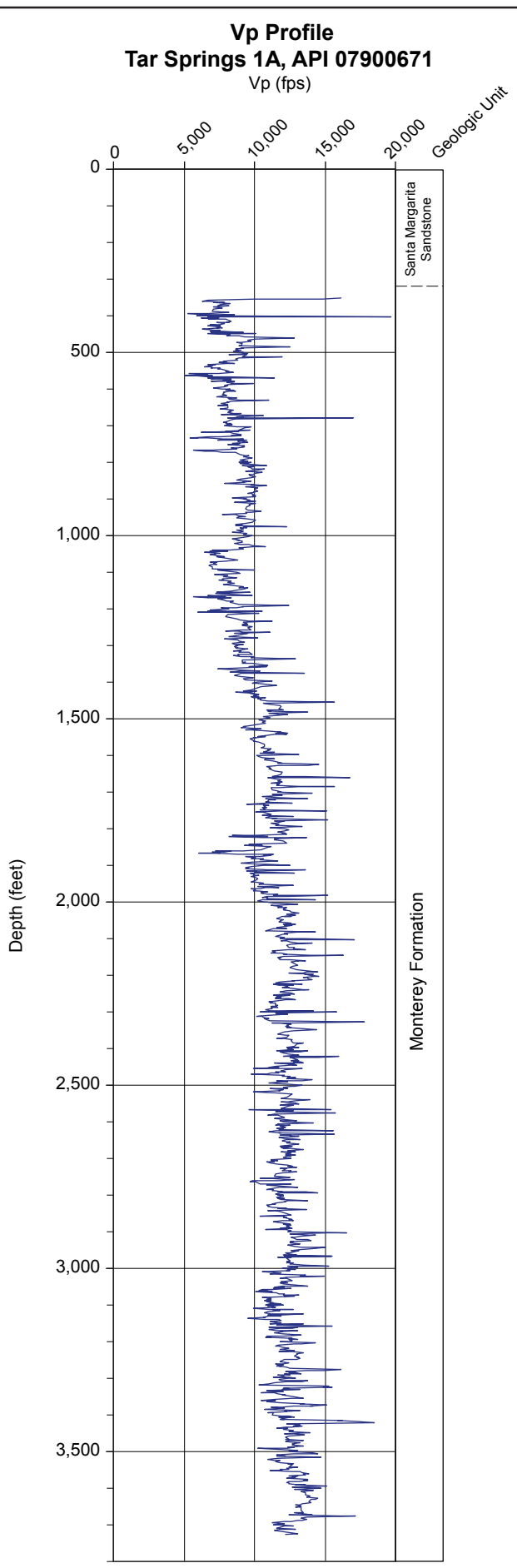


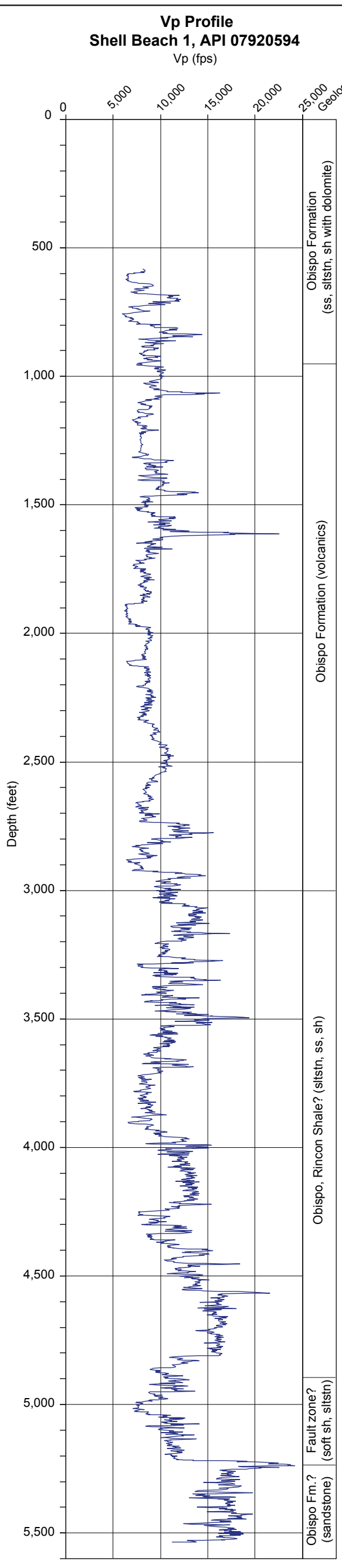

Note: Original data from dipmeter log, deviation log provided in Excel file.

**Deviation of Honolulu-Tidewater 1 Well from Dipmeter Log**

**DCPP GEOLOGIC MAPPING PROJECT**

**Pacific Gas and Electric Company** | Figure **E2-8**




**Sonic Logs for Tar Springs 1A and Shell Beach 1 Wells**

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company | Figure **E2-9**

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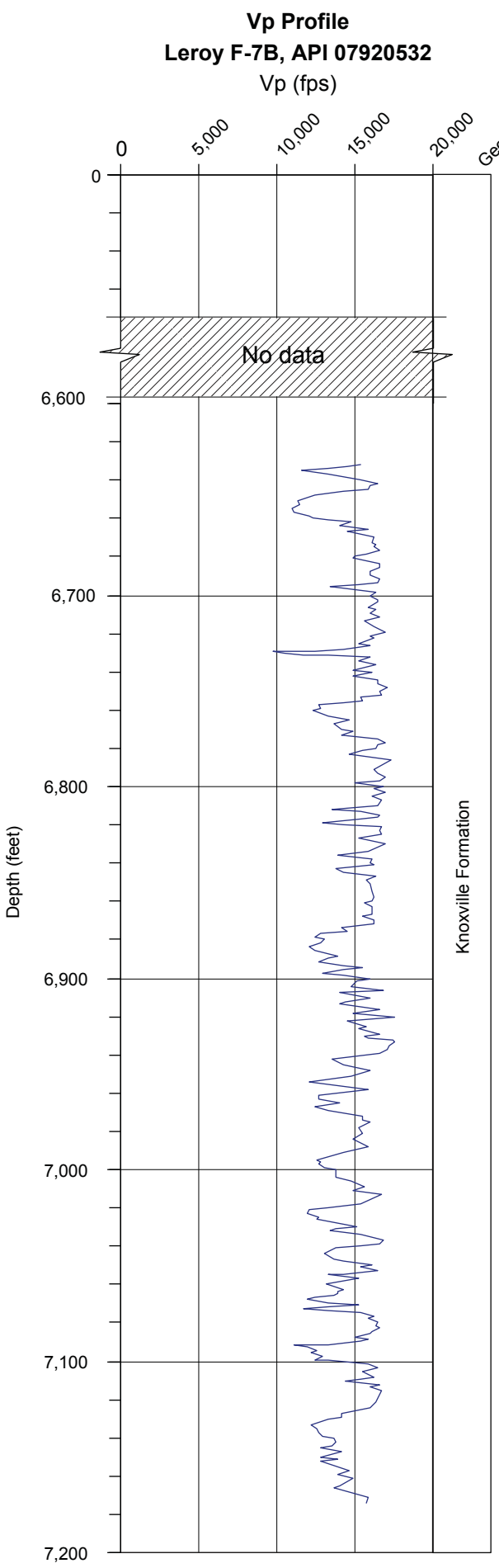
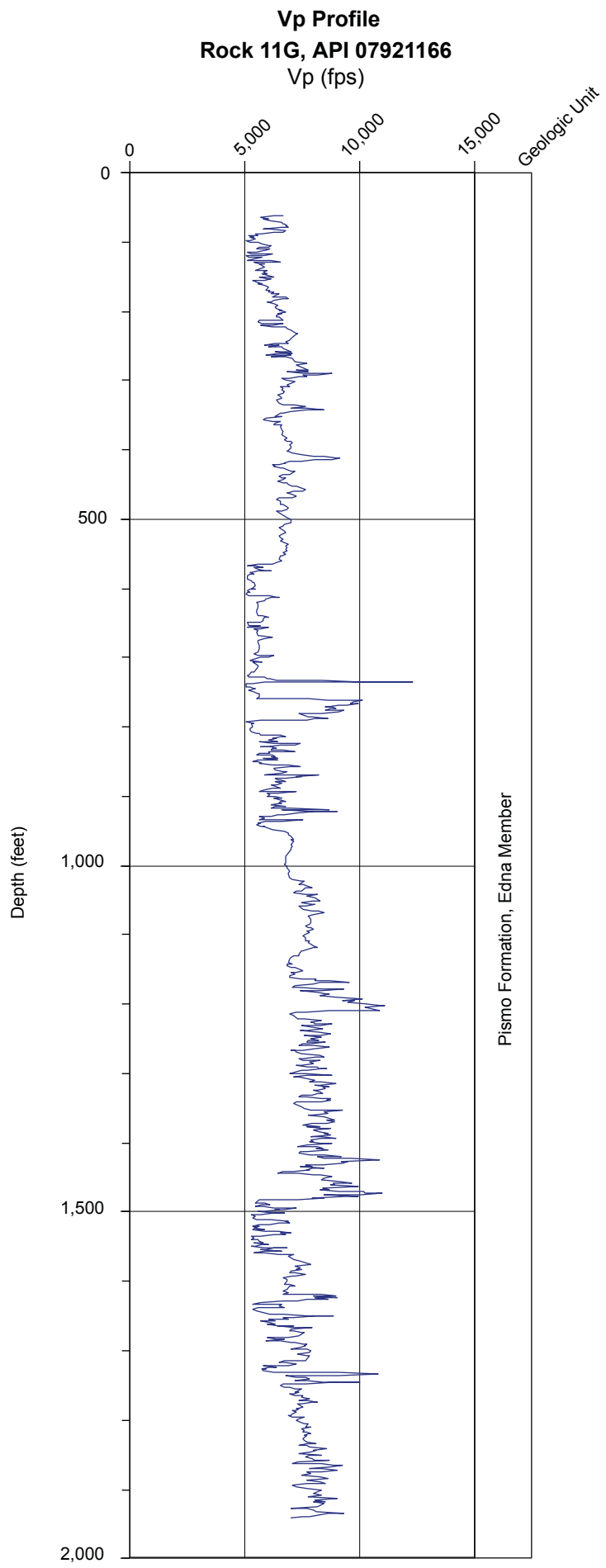


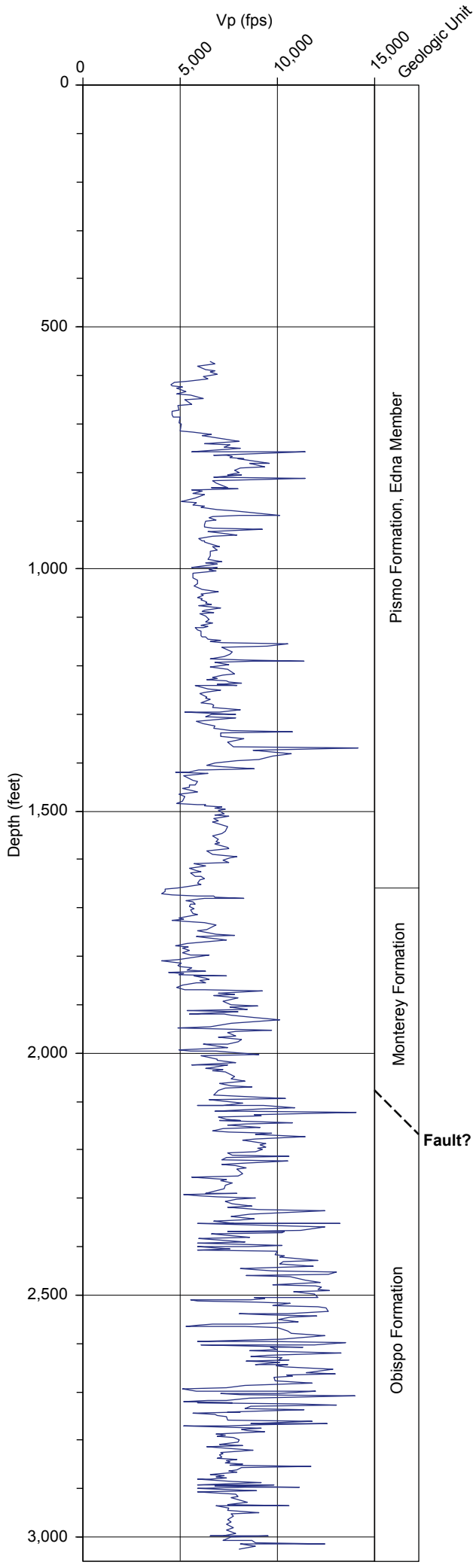

**Sonic Logs for Leroy F-7B and Rock 11G Wells**

**DCPP GEOLOGIC MAPPING PROJECT**

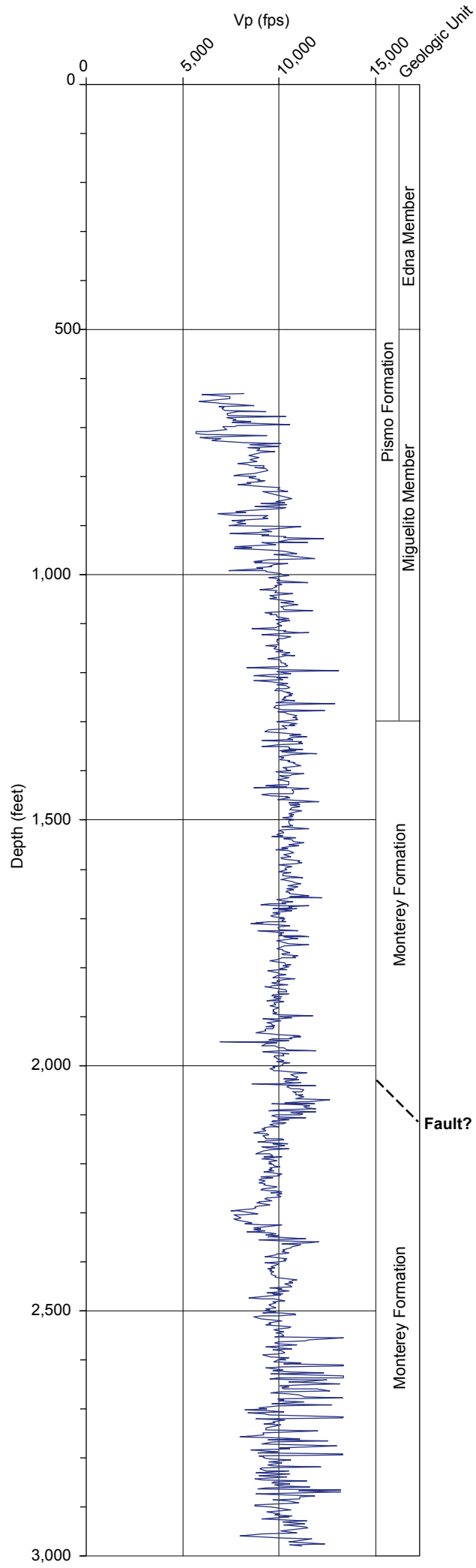
Pacific Gas and Electric Company | Figure **E2-10**

File Path: S:\1005\020\QA_GIS\Final_Figures\Figure_E2-10.ai; Date: 05/29/2014; User: Alex Remar

## Vp Profile
## Guidetti A3, API 07920545




## Vp Profile
## Guidetti A4, API 07920566




**Sonic Logs for Guidetti A3 and Guidetti A4 Wells**

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company | Figure **E2-11**

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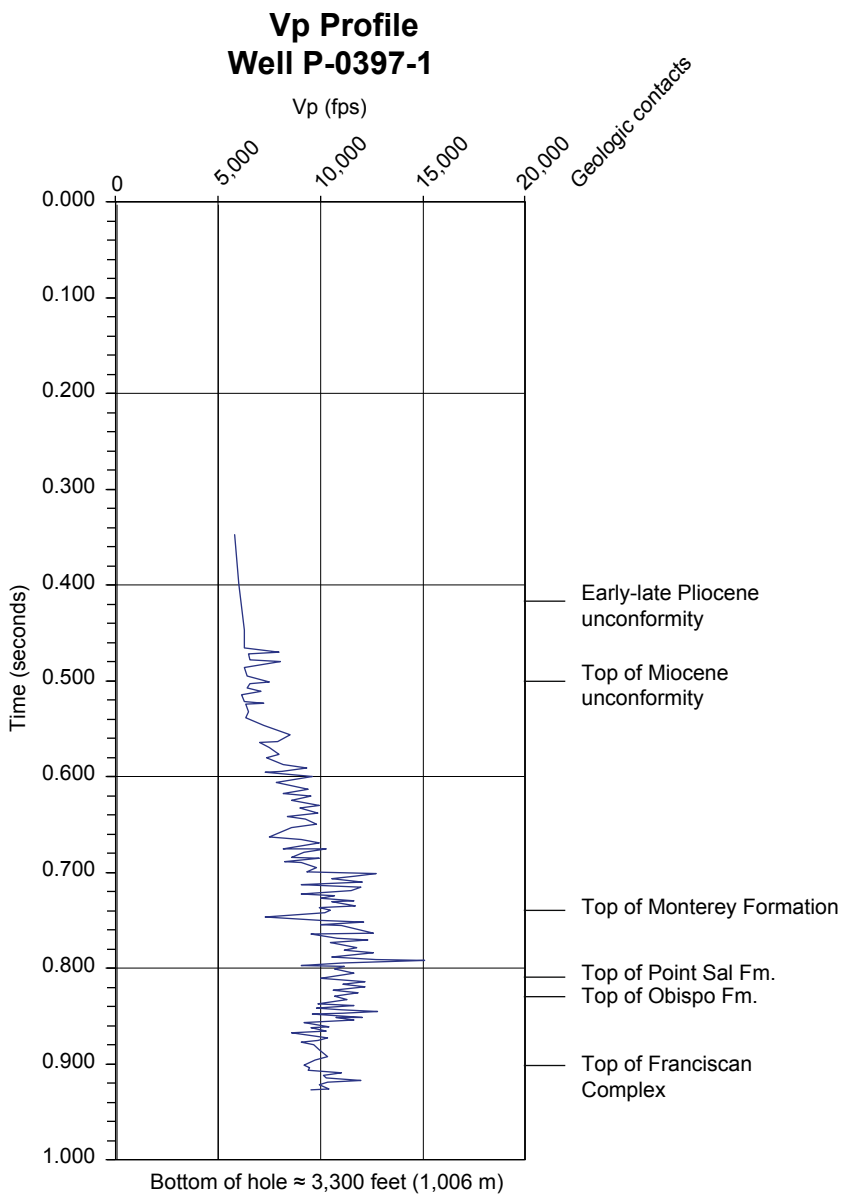


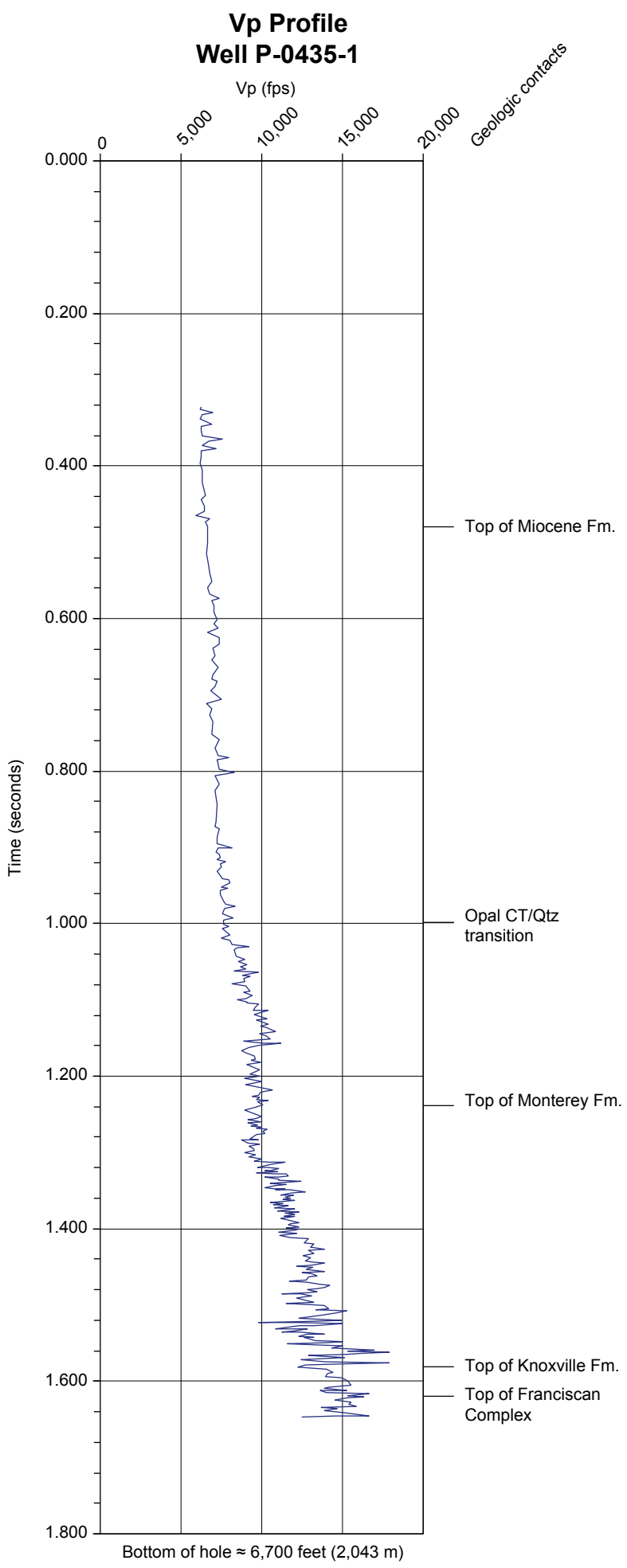


Source: Willingham et al. (2013)
Note: Y-axis units are travel times from seismic reflection data.

**Sonic Logs for Offshore Wells P-0397-1 and P-0435-1**

**DCPP GEOLOGIC MAPPING PROJECT**

Pacific Gas and Electric Company | Figure **E2-12**

File Path: S:\1005\020\QA_GIS\Final_Figures\Figure_E2-12.ai; Date: 05/29/2014; User: Alex Remar