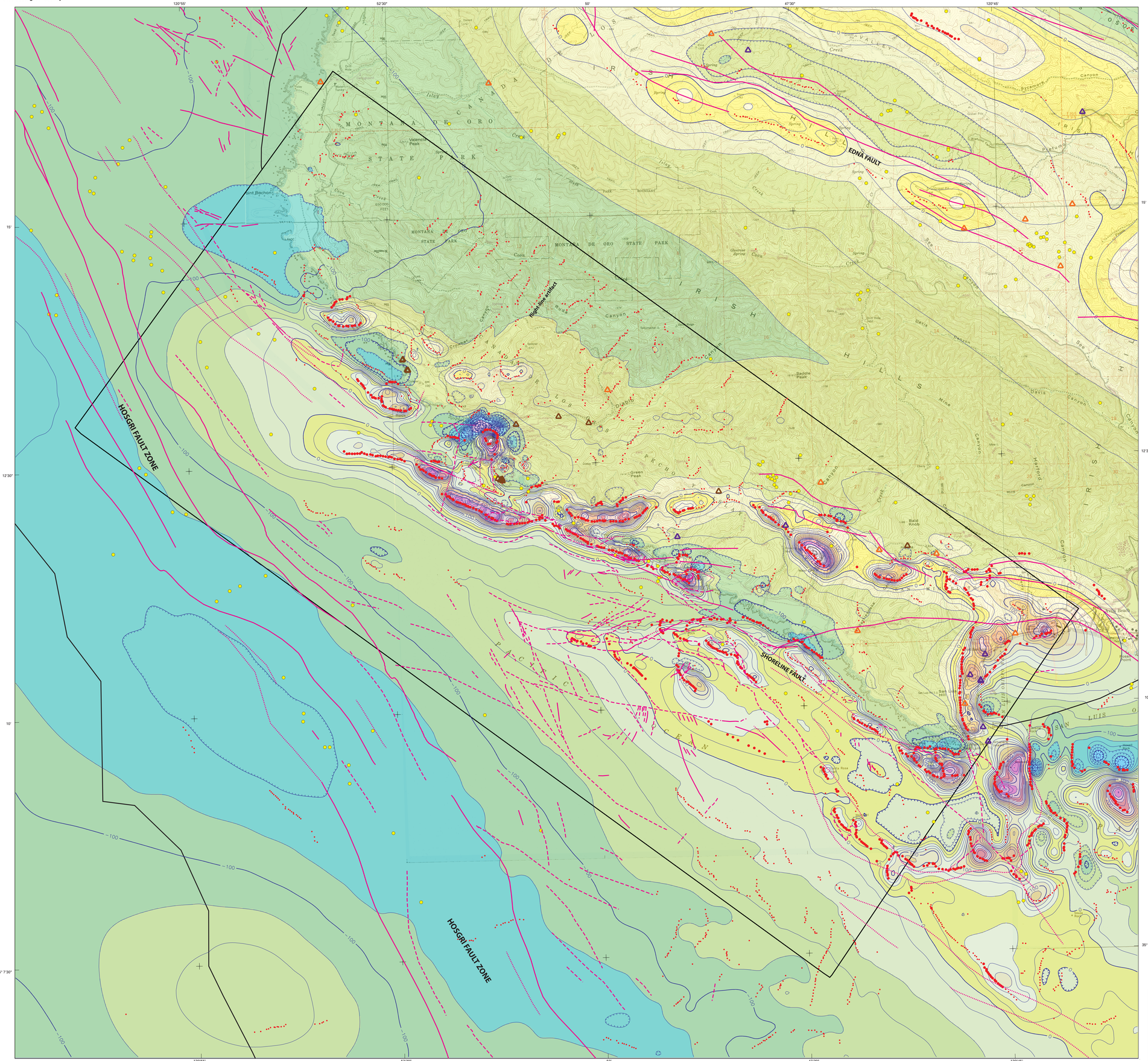
U.S. Department of the Interior
U.S. Geological Survey

Open-File Report 2012-1080



MAP EXPLANATION

Contours of total magnetic field intensity relative to the International Geomagnetic Reference Field. Contour interval is 20 nanoteslas. Hachures indicate closed magnetic lows

Location of maximum horizontal gradient, with amplitudes greater than the mean for the study area

Location of maximum horizontal gradient, with amplitudes less than the mean for the study area

Magnetic survey boundary

Fault—solid where location is accurate; dashed where approximate; dotted where concealed from Pacific Gas and Electric Company (2010; offshore) and Pacific Gas and Electric Company (1988; onshore)

Earthquake epicenter (Hardebeck, 2010)

Rock property measurement (Sedimentary rock)

Rock property measurement (Tertiary volcanic rock)

Rock property measurement (Mesozoic igneous and metamorphic rock)

A magnetic map of the Irish Hills and surrounding areas was created as part of a cooperative research and development agreement with the Pacific Gas and Electric Company and is intended to promote further understanding of the areal geology and structure by serving as a basis for geophysical interpretations and by supporting geological mapping, mineral and water resource investigations, and other topical studies. Local spatial variations in the Earth's magnetic field (evident as anomalies on magnetic maps) reflect the distribution of magnetic minerals, primarily magnetite, in the underlying rocks. In many cases the volume content of magnetic minerals can be related to rock type, and abrupt spatial changes in the amount of magnetic minerals can be related to either lithologic or structural boundaries. Magnetic susceptibility measurements (table 1) from the area indicate that bodies of serpentinite and other mafic and ultramafic rocks tend to produce the most intense magnetic anomalies, but such generalizations must be applied with caution because some sedimentary units also can produce measurable magnetic anomalies. Remanent magnetization does not appear to be a significant source for magnetic anomalies because it is an order of magnitude less than the induced magnetization (table 1).

The map is a mosaic of three separate surveys collected by (1) fixed-wing aircraft at a nominal height of 305 m (Langenheim and others, 2009), (2) by boat with the sensor at sea level (Sliter and others, 2009, revised 2010), and (3) by helicopter (fig. 1). The helicopter survey was flown by New-Sense Geophysics in October 2009 along flight lines spaced 150-m apart and at a nominal terrain clearance of 50 to 100 m. Tie lines were flown 1,500-m apart. Data were adjusted for lag error and diurnal field variations. Further processing included microleveling using the tie lines and subtraction of the reference field defined by International Geomagnetic Reference Field (IGRF) 2005 extrapolated to August 1, 2008.

Data were interpolated to a square grid with a grid interval of 50 m using the principle of minimum curvature (Briggs, 1974). The magnetic base levels of three surveys were then adjusted to bring them onto a common magnetic datum.

Abrupt lateral changes in magnetization that may represent lithologic or structural boundaries were determined as follows:

(1) The total-field magnetic anomaly data were mathematically transformed into pseudogravity anomalies (Baranov, 1957); this procedure effectively converts the magnetic field to the "gravity" field that would be produced if all the magnetic material were replaced by proportionately dense material.

(2) The horizontal gradient of the pseudogravity field was calculated everywhere by numerical differentiation.

(3) Locations of locally steepest horizontal gradient (shown on map as red-filled circles) were determined by numerically searching for maxima in the horizontal gradient grid (Blakely and Simpson, 1986).

Boundaries between bodies having different densities are characterized by steep gradients in the gravity field they produce and, if the boundaries have moderate-to-steep dips (greater than 45°), locally the maximum horizontal gradients will be located over the surface traces of the boundaries (Blakely and Simpson, 1986), especially for shallow sources. Similarly, boundaries between bodies having different magnetizations are characterized by steep gradients in the pseudogravity field and, therefore, the procedure described above can be used to locate these boundaries. For example, the steepest horizontal gradients shown on map by red-filled circles coincide locally with strands of the Edna, Hosgri, and Shoreline Faults.

REFERENCES CITED

Baranov, V.I., 1957, A new method for interpretation of aeromagnetic maps—Pseudo-gravimetric anomalies: Geophysics, v. 22, p. 359-383.

Blakely, R.J., and Simpson, R.W., 1986, Approximating edges of source bodies from magnetic or gravity anomalies: Geophysics, v. 51, p. 1494-1498.

Briggs, I.C., 1974, Machine contouring using minimum curvature: Geophysics, v. 39, p. 39-48.

Hall, C.A., Jr., 1973a, Geologic map of the Morro Bay South and Port San Luis quadrangles, San Luis Obispo County, California: U.S. Geological Survey Miscellaneous Fleld Studies Map MF-511, scale 1:24,000.

Hall, C.A., Jr., 1973b, Geology of the Arroyo Grande 15-minute quadrangle, San Luis Obispo county, California: California Division of Mines and Geology Map Sheet 24, scale 1:62,500, 8 p.

Hardebeck, J.L., 2010, Seismotectonics and fault structure of the California Central Coast: Bulletin of the Seismological Society of America, v. 100, no. 3, p. 1031-1050.

Langenheim, V.E., Jachens, R.C., and Moussaoui, K., 2009, Aeromagnetic Survey Map of the Central California Coast Ranges: U.S. Geological Survey Open-File Report 2009-1044, http://pubs.usgs.gov/of/2009/1044/.

Pacific Gas and Electric Company, 1988, Final Report of the Diablo Canyon Long Term Seismic Program. Docket Nos. 50-275, and 50-323, 700 p, 21 plates.

Pacific Gas and Electric Company, 2010, Appendix B: Geology Plates *in* Report on the Analysis of the Shoreline Fault Zone, Central Coastal California: Report to the U.S. Nuclear Regulatory Commission, 4 plates, scale 1:12,000. [http://www.pge.com/myhome/edusafety/systemworks/dcpp/shorelinereport/].

Sliter, R.W., Triezenberg, P.J., Hart, P.E., Watt, J.T., Johnson, S.Y., and Scheirer, D.S., 2009, revised 2010, High-resolution seismic reflection and marine magnetic data along the Hosgri Fault Zone, Central California: U.S. Geological Survey Open-File Report 2009-1100, version 1.1, http://pubs.usgs.gov/of/2009/1100/.

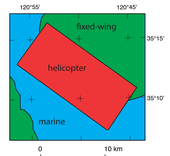


Figure 1. Index map of three magnetic surveys.

Table 1. Magnetic properties of rock samples within map area.

[k/NRM, magnetic susceptibility/natural remanent magnetization; SI, standard international unit; A/m, ampere per meter; *, no data]

Rock Type[1]	Number of samples (k/NRM)	Average Magnetic Susceptibility (x 10^{-3} SI)	Magnetic Susceptibility Range	Average NRM Magnetization (A/m)	NRM Magnetization Range (A/m)	Average Volume Susceptibility (x 10^{-3} SI)	Range Volume Susceptibility (x 10^{-3} SI)	Average Koenigsberger Ratio	Koenigsberger Ratio Range
Sedimentary rocks									
Pismo Formation	8/0	0.06	0.00–0.14	*	*	*	*	*	*
Monterey Formation chert	3/0	0.04	0.02–0.05	*	*	*	*	*	*
Sandstone	2/0	0.17	0.11–0.22	*	*	*	*	*	*
Graywacke	1/0	0.41	0.41	*	*	*	*	*	*
Chert	1/0	0.11	0.11	*	*	*	*	*	*
Tertiary volcanic rocks									
Obispo Formation tuff	4/0	0.07	0.05–0.09	*	*	*	*	*	*
Obispo Formation diabase, weathered	4/4	0.33	0.25–0.41	3.67E-04	2.56E-04 – 5.19E-04	0.37	0.39-0.42	0.03	0.016–0.052
Obispo Formation diabase	13/8	11.97	0.13–32.64	4.33E-02	7.91E-06 – 7.02E-02	13.07	0.34-31.60	0.06	0.009–0.147
Mesozoic igneous and metamorphic rocks									
Basalt	8/2	26.25	15.65–38.10	1.36E-01	0.125–0.146	31.67	29.77 - 33.56	0.10	0.098–0.102
Meta-volcanic rocks	7/0	1.46	0.00–6.33	*	*	*	*	*	*
Serpentinite	3/0	26.27	6.90–39.65	*	*	*	*	*	*

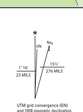
[1]From Hall (1973a, b)

Base from U.S. Geological Survey 7.5-minute quadrangles, Morro Bay South, 1965, Pismo Beach, 1965, Port San Luis, 1963, San Luis Obispo, 1965, revised 1994
Universal Transverse Mercator projection, zone 10, datum NAD27
Central meridian -123.0°
Base latitude 0.0°

SCALE 1:24 000

1 0 1 2 3 4 MILES

1 0 1 2 3 4 KILOMETERS



UTM grid convergence (GN) and 1978 magnetic declination at center of Morro Bay South 1:24,000 scale map. Diagram is approximate

MAP LOCATION

Manuscript approved for publication April 25, 2012

Magnetic Map of the Irish Hills and Surrounding Areas, San Luis Obispo County, Central California

By
V.E. Langenheim, J.T. Watt, and K.M. Denton

2012

Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225, 1-888-ASK-USGS

Digital files available at http://pubs.usgs.gov/of/2012/1080/

Suggested citation: Langenheim, V.E., Watt, J.T., and Denton, K.M., 2012, Magnetic map of the Irish Hills and surrounding areas, San Luis Obispo County, central California: U.S. Geological Survey Open-File Report 2012-1080, scale 1:24,000. (Available at http://pubs.usgs.gov/of/2012/1080/)