



PRELIMINARY AEROMAGNETIC ANOMALY MAP OF CALIFORNIA

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**U.S. DEPARTMENT OF THE INTERIOR
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INTRODUCTION

The magnetization in crustal rocks is the vector sum of induced in minerals by the Earth's present main field and the remanent magnetization of minerals susceptible to magnetization (chiefly magnetite) (Blakely, 1995). The direction of remanent magnetization acquired during the rock's history can be highly variable. Crystalline rocks generally contain sufficient magnetic minerals to cause variations in the Earth's magnetic field that can be mapped by aeromagnetic surveys. Sedimentary rocks are generally weakly magnetized and consequently have a small effect on the magnetic field: thus a magnetic anomaly map can be used to "see through" the sedimentary rock cover and can convey information on lithologic contrasts and structural trends related to the underlying crystalline basement (see Nettleton, 1971; Blakely, 1995).

The magnetic anomaly map (fig. 2) provides a synoptic view of major anomalies and contributes to our understanding of the tectonic development of California. Reference fields, that approximate the Earth's main (core) field, have been subtracted from the recorded magnetic data. The resulting map of the total magnetic anomalies exhibits anomaly patterns related to the distribution of magnetized crustal rocks at depths shallower than the Curie point isotherm (the surface within the Earth beneath which temperatures are so high that rocks lose their magnetic properties). The magnetic anomaly map has been compiled from existing digital data. Data obtained from aeromagnetic surveys that were made at different times, spacings and elevations, were merged by analytical continuation of each set onto a common surface 305 m (1000 ft) above terrain. Digital data in this compatible form allows application of analytical techniques (Blakely, 1995) that can be used to enhance anomaly characteristics (e.g., wavelength and trends) and provide new interpretive information.

This report in PDF format (file name OF99-440.PDF) and other geophysical studies may be found on the Internet site of the Geophysical Unit in Menlo Park at:
<http://wrgis.wr.usgs.gov/docs/gump>

DATA REDUCTION

The magnetic anomaly map was compiled from a group of magnetic surveys with diverse specifications (table 1). The 123 aeromagnetic surveys were flown with flight-line spacings ranging from 0.4 km (1/4 mi) to 10 km (6 mi) and either in a drape mode (approximately constant elevation above ground surface) or in a level mode (constant Barometric altitude). In all cases the total field component was used. To produce a coherent magnetic database, the following procedures were applied to the individual surveys:

1. The International Geomagnetic Reference Field (IGRF), updated to the date that the survey was flown, was removed from each survey to generate an initially consistent set of residual data.

2. All surveys were then gridded at a 1-km spacing (Lambert Conformal Conic projection, central meridian 120°, base latitude 0°) and continued on a common datum of 305 m (1000 ft) above the ground surface. Surveys not collected at this height were mathematically modified to approximate the magnetic field that would have been measured at the 305-m common datum (Cordell, 1985).
3. The individual surveys were compared in areas of overlap, datum shifted as necessary to give the best fit, and finally merged into a single grid using a minimum curvature algorithm (Webring, 1982) to smoothly fill across gaps of about 2 km between surveys.

The overall precision of the anomaly values is difficult to estimate, mainly because of the diversity of surveys used to construct the map. Very rugged topography and concerns about safety caused significant departures from the ideal flight surface on many draped surveys. Because of the wide 10-km (6-mi) spacing of surveys 6150 and 6184, expressions of near-surface sources may have been misrepresented or not detected because of lack of resolution. Continuing of the data to the common reference level of 305 m above the ground can also introduce errors in the anomaly map. The final data set is judged suitable to gain new insights into regional geologic features at scales of 1:250,000 or smaller.

Note: This and other recent USGS publications in the Western Region may be found on the World Wide Web at: <http://geopubs.wr.usgs.gov>. See also <http://wrgis.wr.usgs.gov>.

ACNOWLEDGMENT

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Table 1. Specifications of aeromagnetic surveys of California.

Index # (Fig 1.)	Name	Date Flown	Flight line	Flight dir.	Altitude	Datum	Publication (see References)
0021	Mother Lode '51	09/51	0.5 mi.	E-W	1000 Above ground	Arbitrary	GP-561
0022	Bakersfield	03/50	1 mi.	E-W	2000 Barometric	Arbitrary	CA Bul.190
0028	Kramer	02/54	0.25 mi.	N-S	500 Above ground	Arbitrary	GP-680
0034	San Francisco Bay	03/50-08/51	1 mi.	E-W	1000 Above ground	Arbitrary	OF71-294
0035	Searles Lake	07/53	1 mi.	E-W	3100 Barometric	Arbitrary	GP-695
0182	Garlock '55	07/55	0.5 mi.	N-S	750 Above ground	Arbitrary	GP-695
0242	Long Valley '56	08/56	1 mi.	E-W	9000 Barometric	Arbitrary	GP-329
0271	Black Mountains (Death V.)	06/57	1 mi.	N-S	7000 Barometric	Arbitrary	GP-428
0273	Garlock Extension	06/57	1 mi.	NW-SE	750 Above ground	Arbitrary	GP-695
0306	San Francisco ARMS '58	10/58-11/58	1 mi.	NE-SW	500 Above ground	Arbitrary	GP-574
0329A	Los Angeles ARMS South	05/59	1 mi.	N-S	500 Above ground	Arbitrary	GP-464,465,466
0329C	Los Angeles ARMS North	05/59	1 mi.	N-S	500 Above ground	Arbitrary	GP-695
0331A	San Francisco ARMS N. '59	04/59-05/59	1 mi.	NE-SW	500 Above ground	Arbitrary	GP-574
0331B	San Francisco ARMS S. '59	04/59-05/59	1 mi.	NE-SW	500 Above ground	Arbitrary	GP-574
0509	Stonyford	10/62	1 mi.	E-W	7000 Barometric	Arbitrary	B-1495
0522A	Sierra Nevada '63 West	10/63	1 mi.	E-W	2500 Barometric	Arbitrary	GP-657
0522B	Sierra Nevada '63 Central	10/63	1 mi.	E-W	8000 Barometric	Arbitrary	GP-657
0522C	Sierra Nevada '63 East	10/63	1 mi.	E-W	13,500 Barometric	Arbitrary	GP-657
0541	Salton Sea '65	08/65	0.5-1 mi.	E-W	800 Barometric	Arbitrary	GP-754
0576	Burro Mountain	09/66	0.5-1 mi.	NE-SW	4000 Barometric	Arbitrary	P-700B
0605A	Garlock West '67	05/67	1 mi.	E-W	6000 Barometric	Arbitrary	GP-695
0605B	Garlock East '67	05/67	1 mi.	E-W	6000 Barometric	Arbitrary	GP-695
0618	Mother Lode North	09/67	0.5 mi.	E-W	1000 Above ground	Arbitrary	GP-671
0619A	Grass Valley--Nevada City	09/67	0.5 mi.	N-S	3500 Barometric	Arbitrary	OF76-274
0619B	Grass Valley--Alleghany	09/67	0.5 mi.	N-S	5500 Barometric	Arbitrary	OF76-274
0677	High Sierra	04/70	1 mi.	E-W	14,000 Barometric	Arbitrary	B-1371A
0678	Trinity Alps	04/70	1 mi.	E-W	8500 Barometric	Arbitrary	B-1371B
0694	South Warner	09/70	1 mi.	N-S	10,000 Barometric	Arbitrary	B-1385D
1007	Clear Lake '72	05/72	1 mi.	E-W	4500 Barometric	Arbitrary	OF73-299
1019	Southeastern California	03/73-04/73	1 mi.	E-W	9000 Barometric	Arbitrary	OF75-052
1140	San Jose	11/89-04/90	0.25 mi.	NE-SW	500 Above ground	DIGRF	OF91-030
1141	Palo Alto	02/90	0.25 mi.	NE-SW	800 Above ground	DIGRF	OF91-336
3002A	Western Nevada	02/67-05/67	1 mi.	E-W	9000 Barometric	Arbitrary	GP-751,753
3002B	Western Nevada - Tahoe	02/67-05/67	1 mi.	E-W	11,000 Barometric	Arbitrary	GP-751
3002C	Western Nevada - Aurora	02/67-05/67	1 mi.	E-W	11,000 Barometric	Arbitrary	GP-751
3027	Eastern California	07/73-08/73	1 mi.	E-W	13,500 Barometric	IGRF65, 51374	OF74-1109
3037	Carrizo Plain	06/73-10/73	1 mi.	NE-SW	6500 Barometric	IGRF65, +1000	OF74-008
3038	San Francisco	07/73-09/73	1 mi.	NE-SW	3000 Barometric	IGRF65, +1000	OF74-079-081
3067	Coso Hot Springs '75	03/75-04/75	1 mi.	N-S	7000 Barometric	POGO, 50882	OF76-698
3078	Cucamonga '75	06/75-08/75	1 mi.	N-S	9500 Barometric	IGRF65, 50437	B-1506
3101	California Coast	07/76-09/76	1 mi.	NE-SW	2000 Barometric	IGRF75, 50680	OF77-079

Index # (Fig 1.)	Name	Date Flown	Flight line	Flight dir.	Altitude	Datum	Publication (see References)
3110	Crescent City	03/77-05/77	0.5 mi.	E-W	3800 Barometric	IGRF75, 53038	OF83-652
3111	Wendel	03/77-05/77	0.5 mi.	E-W	8000 Barometric	IGRF75, 53022	OF77-795
3114	SW Ventura County	10/77-11/77	2 mi.	N-S	1000 Above ground	IGRF75	OF80-064
3132	Yolla Bolly	07/78	0.5 mi.	E-W	1000 Above ground	IGRF75, 53561	OF79-1196
3133	North Fork American	07/78	0.67 mi.	NE-SW	1000 Above ground	IGRF75, 53561	OF79-1197
3134A	Hoover-Walker Lake	07/78	1 mi.	E-W	1000 Above ground	IGRF75, 53561	OF79-1194
3134B	Hoover-Walker Lake S-Cent.	07/78	0.5 mi.	E-W	1000 Above ground	IGRF75, 53561	OF79-1194
3134C	Hoover-Walker Lake SE	07/78	1 mi.	E-W	1000 Above ground	IGRF75, 53561	OF79-1194
3135	Devils Postpile	07/78	0.5 mi.	E-W	1000 Above ground	IGRF75, 53561	OF79-1193
3136	Black Cap Mountain	07/78	0.5 mi.	E-W	1000 Above ground	IGRF75, 53561	OF79-1207
3137C	Lathrop Wells South	06/78	0.5 mi.	E-W	400 Above ground	IGRF75, 51837	OF78-1103
3153	Marble Mountains	03/79-04/79	0.5 mi.	N60E	1000 Above ground	IGRF75, 53500	OF79-1228
3158	Mokelumne	03/79	0.5 mi.	NE-SW	1000 Above ground	IGRF75, 53500	OF79-1233
3159	Domelands	01/79-03/79	0.5 mi.	E-W	1000 Above ground	IGRF75, 51300	OF79-1234
3167	Golden Trout	04/79-05/79	0.5 mi.	E-W	1000 Above ground	IGRF75, 52000	OF79-1459
3168	S. San Bernardino Mtns.	04/79-05/79	0.5 mi.	N-S	1000 Above ground	IGRF75, 50000	OF79-1448
3179	Granite Peak	10/79-11/79	0.5 mi.	E-W	1000 Above ground	IGRF75, 52434	OF80-949
3180	Los Padres	11/79	0.5 mi.	NE-SW	1000 Above ground	IGRF75, 50125	OF80-986
3181	North Sierra Foothills	04/81	0.5 mi.	NE-SW	1000 Above ground	IGRF75	OF84-786
3182	South Sierra Foothills	03/81-04/81	0.5 mi.	NE-SW	1000 Above ground	IGRF75	OF83-055
3199	Sierra Nevada '80	11/80-12/80	0.5 mi.	NE-SW	1000 Above ground	IGRF75	unpublished
4010	Tioga Lake	06/80	0.5 mi.	NE-SW	1000 Above ground	IGRF75, +5000	OF81-432
4011	Dardanelles	06/80	0.5 mi.	E-W	1000 Above ground	IGRF75, +5000	OF81-431
4012	Cucamonga Peak	06/80	0.5 mi.	NE-SW	1000 Above ground	IGRF75, 49898	OF81-086
4024	Needles	01/80-07/80	0.5 mi.	E-W	1000 Above ground	IGRF75, +5000	OF81-085
4045	Condrey Mountain	03/81	0.5 mi.	E-W	1000 Above ground	IGRF75, 53092	OF82-550
4046	Orleans Mountain	03/81	0.5 mi.	E-W	1000 Above ground	IGRF75, 52570	OF82-1082
4047	Sweetwater	04/81	0.5 mi.	E-W	1000 Above ground	IGRF75, 51927	OF82-066
4048	Kings River	04/81	0.5 mi.	E-W	1000 Above ground	IGRF75, 50962	OF82-657
4049	Black Buttes-Ventana	03/81	0.5 mi.	NE-SW	1000 Above ground	IGRF75, 49975	OF82-947
4050	Bighorn	04/81	0.5 mi.	N-S	1000 Above ground	IGRF75, 49470	OF82-664
4051	Cactus Springs	03/81	0.5 mi.	E-W	1000 Above ground	IGRF75, 49462	OF82-945
4058A	White & Inyo Mountains A	04/81-09/81	0.5 mi.	E-W	14,500 Barometric	IGRF75, 50923	OF83-656
4058B	White & Inyo Mountains B	04/81	0.5 mi.	E-W	8000 Barometric	IGRF75 51392	OF83-654
4058C	White & Inyo Mountains C	04/81-09/81	0.5 mi.	E-W	7000 Barometric	IGRF75, 51079	OF83-655
4058D	White & Inyo Mountains D	04/81-09/81	0.5 mi.	E-W	7000 Barometric	IGRF75, 50791	OF83-653
4070	Inyo Extension	09/81	0.5 mi.	E-W	11,000 Barometric	IGRF80, 50976	OF82-1081
4071	Panamint Dunes	09/81	0.5 mi.	E-W	7000 Barometric	IGRF80, 50924	OF82-1085
4072	Sierra Owens	09/81	0.5 mi.	E-W	9000 Barometric	IGRF80, 50596	OF82-1083
4073	Kingman-Trona	09/81-12/81	0.5 mi.	E-W	1000 Above ground	IGRF80, 50942	OF83-663
4074A	Salton Sea South '81	10/81-12/81	0.5 mi.	E-W	1000 Above ground	IGRF80, 49009	OF83-664
4074B	Salton Sea North '81	10/81-12/81	0.5 mi.	E-W	1000 Above ground	IGRF80, 49009	OF83-664
4100	Eagle Mountains	?/54	var.	var.	var.	Arbitrary	OF84-502

Index # (Fig 1.)	Name	Date Flown	Flight line	Flight dir.	Altitude	Datum	Publication (see References)
4102	Palen	?/55	0.25 mi.	var.	500 Above ground	Arbitrary	OF85-281
4103	Ord Mountains	?/57-?/58	0.5 mi.	var.	500 Above ground	Arbitrary	OF87-005
4134	Redding	01/85-02/85	0.5 mi.	E-W	1000 Above ground	IGRF80, 51652	OF85-757
4141	Clear Lake '85	09/85-10/85	0.5 mi.	E-W	1000 Above ground	IGRF80	OF88-507
4142	Parkfield	12/85-02/86	0.5 mi.	NE-SW	1000 Above ground	IGRF80	OF87-092
4148	Central Sierra Nevada	?/56	0.37-0.75 mi.	NE-SW	500 Above ground	Arbitrary	OF84-216
4154	San Diego	03/89	0.5 mi.	N55E	1000 Above ground	IGRF85, 48500	OF90-206
4155	Livermore	10/91-12/91	0.33 mi.	NE-SW	1000 Above ground	IGRF85	OF92-531
4158	Cape Mendocino East	08/93-02/94	0.5 mi.	N45E	1000 Above ground	IGRF90	OF94-444
6059	Trona	11/77-01/78	3 mi.	E-W	400 Above ground	IGRF65	GJBX-065(79)
6060	Death Valley	11/77-01/78	1 mi.	N-S	400 Above ground	IGRF65	GJBX-164(79)
6110	Salton Sea	02/79-03/79	3 mi.	N-S	400 Above ground	IGRF75	GJBX-012(80)
6149	South-central California- Bakersfield, Fresno,	10/79-11/79	3 mi.	E-W	400 Above ground	IGRF75	GJBX-231(80)
6150	Southwest Fresno	10/79-11/79	6 mi.	E-W	400 Above ground	IGRF75	GJBX-231(80)
6151	Southern California-Los Angeles, Santa Maria,	11/79-02/80	3 mi.	E-W	400 Above ground	IGRF75	GJBX-214(80), 20(81), 50(81)
6159	Sacramento	02/80-07/80	3 mi.	E-W	400 Above ground	IGRF75	GJBX-051(81)
6184	Northern California-Ukiah, Weed, Crescent City,	08/80-10/80	6 mi.	E-W	400 Above ground	IGRF75	GJBX-390(81), 391(81), 409(81), 410(81), 411(81)
6185	Chico	08/80-10/80	3 mi.	E-W	400 Above ground	IGRF75	GJBX-407(81)
CA01A	Coastal California N.	?/54	1 mi.	NE-SW	3000 Barometric	Arbitrary	CA B-190, unpublished
CA01B	Coastal California S.	?/54	1 mi.	NE-SW	3000 Barometric	Arbitrary	GP-932
CA03C	Modoc North-central	?/57	2 mi.	N-S	7000 Barometric	?	CA OF78-13A
CA03D	Modoc South-central	?/57	2 mi.	N-S	8000 Barometric	?	CA OF78-13A
CA03E	Modoc East	?/57	2 mi.	N-S	9500 Barometric	?	CA OF78-13A
CA06A	N. Great Valley - Northeast	?/51	1 mi.	E-W	3500 Barometric	?	CA OF78-13D
CA06B	N. Great Valley - Southeast	?/51	1 mi.	E-W	2500 Barometric	?	CA OF78-13D
CA06C	N.G.V. - Sutter Buttes	?/51	1 mi.	E-W	5000 Barometric?	?	CA OF78-13D
CA06D	N.G.V. - Northwest	?/51	1 mi.	E-W	4500 Barometric?	?	CA OF78-13D
CA06E	N.G.V. - Newville	?/51	1 mi.	E-W	3500 Barometric?	?	CA OF78-13D
CA06F	N.G.V. - Stony River	?/51	1 mi.	E-W	4500 Barometric?	?	CA OF78-13D
CA06G	N.G.V. - Wilbur Springs	?/51	1 mi.	E-W	5000 Barometric?	?	CA OF78-13D
CA06H	N.G.V. - Mt. Vaca	?/51	1 mi.	E-W	4500 Barometric?	?	CA OF78-13D
CA08	North Coastal Area	12/64	0.5-1 mi.	N30E	500 Above ground	Arbitrary	CA OF78-13E
CA08B	North Coastal Area SE	12/64	0.5-1 mi.	N30E	500 Above ground	Arbitrary	unpublished
CA09	North Coastal Extension	12/64	0.5-1 mi.	NE-SW	500 Above ground	Arbitrary	CA OF78-13E
CA22	Coso Hot Springs '77	09/77	0.25 mi.	N-S	750 Above ground	?, 50000	IDO-1601-2
CA23	California Cascades	06/80-08/80	1 mi.	E-W	9000 Barometric	IGRF75	OF82-198
CA24	Lassen Peak '80	06/80-08/80	0.5 mi.	E-W	11,000 Barometric	IGRF75	OF82-932
CA25	Mount Shasta '80	06/80-08/80	0.5 mi.	E-W	15,000 Barometric	IGRF75	OF82-932
CA26	Twenty-Nine Palms	09/82	1 mi.	N-S	1000 Above ground	?	unpublished

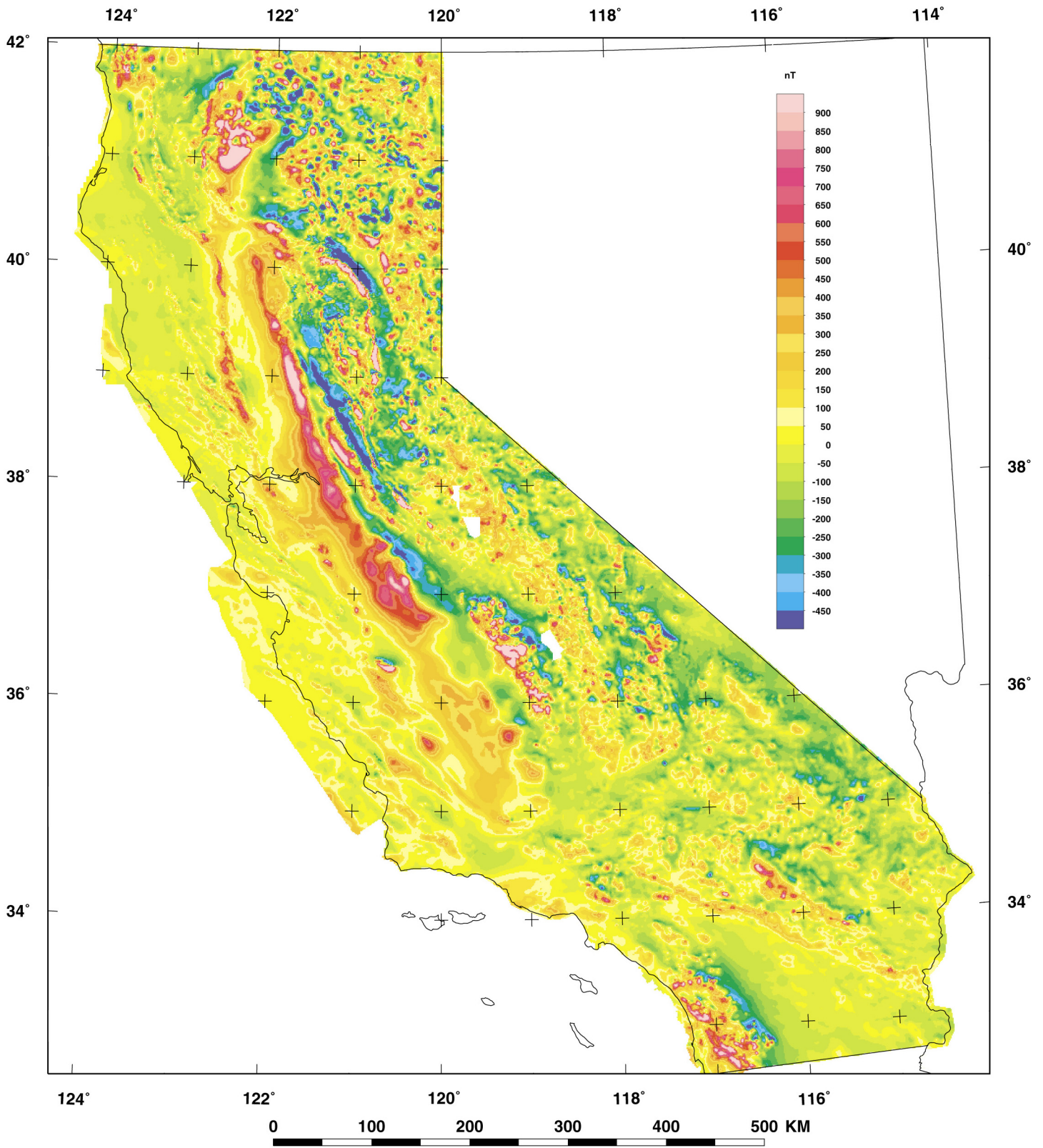


Figure 2. Preliminary aeromagnetic anomaly map of California.