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U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

STATUS OF AEROMAGNETIC SURVEY COVERAGE OF YUCCA MOUNTAIN AND VICINITY TO A RADIUS OF ABOUT 140 KILOMETERS, SOUTHWESTERN NEVADA AND SOUTHEASTERN CALIFORNIA, 1992

By

R.F. Sikora, D.A. Ponce, and H.W. Oliver

Accession Number: NNA.931104.0012

Open-File Report 93-44

Prepared in cooperation with the
NEVADA OPERATIONS OFFICE
U.S. DEPARTMENT OF ENERGY
(Interagency Agreement DE-AI08-78ET44802)

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Company names are for descriptive purposes only and do not constitute endorsement by the U.S. Geological Survey.

Menlo Park, California
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ABSTRACT

Fifty aeromagnetic surveys in the southwestern part of Nevada and the southeastern part of California have been evaluated to assess the quality and coverage of aeromagnetic data within 140 kilometers (km) of a potential nuclear waste repository at Yucca Mountain, Nevada. The compilation shows that all the study area is covered by aeromagnetic surveys, but in some areas, particularly in the Death Valley region, new surveys flown with closer flight line spacing and lower elevations than the existing coverage are needed. In addition, the California part of the study area needs to be analytically continued downward to 305 meters (m) above ground level to provide a consistent data set for interpretation of subsurface geologic structures.

INTRODUCTION

Aeromagnetic surveys in the southwestern part of Nevada and the southeastern part of California were evaluated as part of an effort to assess the quality and coverage of the aeromagnetic data within 140 km of a potential nuclear waste repository at Yucca Mountain, Nevada (U.S. Department of Energy, 1988). These data are of intrinsic value in characterizing geologic structure and mineral resource potential. The study area extends from latitudes 35°30' to 38° N. and longitudes 115° to 118° W. (fig. 1). This report includes a listing of 50 aeromagnetic surveys including various parameters of each survey, such as boundaries, spacing of flight lines and types of surveys.

AEROMAGNETIC SURVEYS

Fifty aeromagnetic surveys have been flown in the study area (table 1, fig. 1). Table 1 lists the flight specifications of each survey including the name of the survey area, year flown, flight contractor, flight elevation, flight-line spacing, flight-line direction, scale of the published survey, whether or not a regional gradient was removed, and if the aeromagnetic data exists in digital or analog form. Flight-line specifications were originally in feet for elevations and miles for spacing. Both have been converted to km. Previous reports by Erwin and others (1980) and Hill (1986) greatly aided in the process of identifying surveys. Figure 1 outlines the boundaries

of each of the individual surveys listed in table 1. Numbering of these areas incorporated previous nomenclature of earlier reports whenever possible.

Figure 2 summarizes the flight-line spacings and whether a survey was flown at a constant barometric elevation or draped at a constant height above terrain. Aeromagnetic surveys were divided into six levels of quality, ranging from 0.4- to 0.8-km spaced data to 1.6- to 4.8-km spaced National Uranium Resource Evaluation (NURE) data (U.S. Department of Energy, 1979a-f). NURE data cover the entire study area and are only shown on figure 3 where no other surveys exist.

Figure 2 helps to delineate areas where the data coverage is inadequate for regional and detailed modeling of structures. Less than 40 percent of the surveys are in digital form, and many were flown and compiled in the late 1950's to mid-1960's. About 75 percent of the surveys were flown at a constant elevation of over 2.3 km and 65 percent have a profile spacing of 1.6 km or greater. NURE data, about 11 percent of the total area, are the only magnetic survey data available for a large area west of Yucca Mountain. These NURE surveys are inadequate because the flight spacings (4.8 km in general, 1.6 km over the Death Valley area) are too large, relative to the 120-m terrain clearance. The minimum flight-spacing/height ratio of the NURE data is about 13, much larger than the generally recommended ratio of 2 for quality interpretation of aeromagnetic surveys (Reid, 1980). By comparison with overlapping 0.4-km spaced data in the Amargosa Desert, just east of Death Valley, the NURE magnetic data were found to miss about a third of the small near-surface magnetic anomalies thought to be volcanic centers buried by alluvium.

Nevada aeromagnetic surveys have recently been merged and analytically continued to 305 m (Hildenbrand and Kucks, 1988). However, individual magnetic surveys in California have not been merged. Merging the California surveys would help in the overall interpretation of the study area by creating one map across the California-Nevada border at the same datum. Many individual surveys still need to be evaluated for possible data and location errors. Some surveys that are available in digital form might be on tapes that are no longer readable (P.L. Hill, U.S. Geological Survey, written commun., 1990). Additional work will be required to assess and merge any new aeromagnetic surveys to a distance of 100 km from Yucca Mountain.

Although all of the regional study area is covered by some type of aeromagnetic survey, data for the regions just west of the site area toward and including Death Valley are inadequate for the regional geologic characterization of the potential Yucca Mountain repository (fig. 2).

MAGNETIC ANOMALY MAP

A mosaicked aeromagnetic map of the study area (fig. 3) was derived from two aeromagnetic compilations. The Nevada part is a subset of a statewide compilation by Hildenbrand and Kucks (1988), and includes many, but not all of the aeromagnetic surveys shown in that part of Nevada (fig. 2). Each survey was gridded at a 1-km interval, corrected for a regional field, merged, and analytically continued to 305 km above the terrain. The California portion of the aeromagnetic map is from the residual total magnetic anomaly map of the Great Basin by Hildenbrand and others (1988). It is a compilation of surveys with various flight spacings and elevations. These data were analytically continued to a barometric elevation of 3.8 km above sea level and gridded at a 2-km interval. Thus, the

California portion is not as detailed as the lower-level magnetic compilation in Nevada.

An interpretation of the geologic significance of the magnetic anomalies shown in figure 3 is beyond the scope of the present paper. Briefly, regional magnetic highs of several hundred nT occur over mountainous areas in California east of Owens Lake, south of China Lake, and parts of the Funeral Mountains along the California-Nevada border. A large magnetic high occurs over the Spring Mountains, about 40 km west of Las Vegas and is probably caused by a broadly domed upwarp of Precambrian basement (Blank, 1988). Part of this magnetic high over the Spring Mountains is coincident with a shorter wave-length 15-mGal gravity low suggesting the existence of an iron-rich low-density intrusion within the Precambrian basement (H.R. Blank, U.S. Geological Survey, written commun., 1989).

Anomaly A (fig.3) occurs over the northern parts of Yucca Mountain and the depth to the top of the source has been estimated at about 2.1 km from detailed data (G.D. Bath, U.S. Geological Survey, written commun., 1984). The source of the magnetic anomaly is currently unknown, but could be a westward extension of the magnetic argillite under Calico Hills. Anomaly B (fig. 3) has been drilled and found to be caused by magnetic-bearing argillite (Kane and Bracken, 1983). Some of the short wave-length anomalies in Nevada between latitudes 37° N. and 38° N. are associated with intrusions, both exposed and buried (Grauch and others, 1988). Two such anomalies located at Wahmonie (marked by C, fig. 3) and the Climax stock (D, fig. 3) have been studied by Ponce (1984) and Bath and others (1983), respectively.

Blakely (1988) discussed the regional significance of the Nevada magnetic data and has computed from them the depth of the Curie isotherm to be about 15 km under Yucca Mountain and to vary from 10 to 30 km under the Nevada portion of the study area. No Curie isotherm depths are presently available for the California portion of the study area.

CONCLUSION

Some aeromagnetic surveys used in the statewide compilation of parts of California and Nevada, particularly in the Death Valley area west of Yucca Mountain, are inadequate for the purposes of interpretation of subsurface geologic structures for the regional geologic characterization of the potential Yucca Mountain repository. Thus, new surveys need to be flown over these areas, and a merged aeromagnetic map continued to 305 m above terrain should be compiled for the study area using new higher quality data, closer flight-line spacing, and lower flight-line elevation.

Measurement Conversions:

1 kilometer (km) = 0.6214 mile

To convert kilometers (km) into miles, multiply the number of kilometers by 0.6214

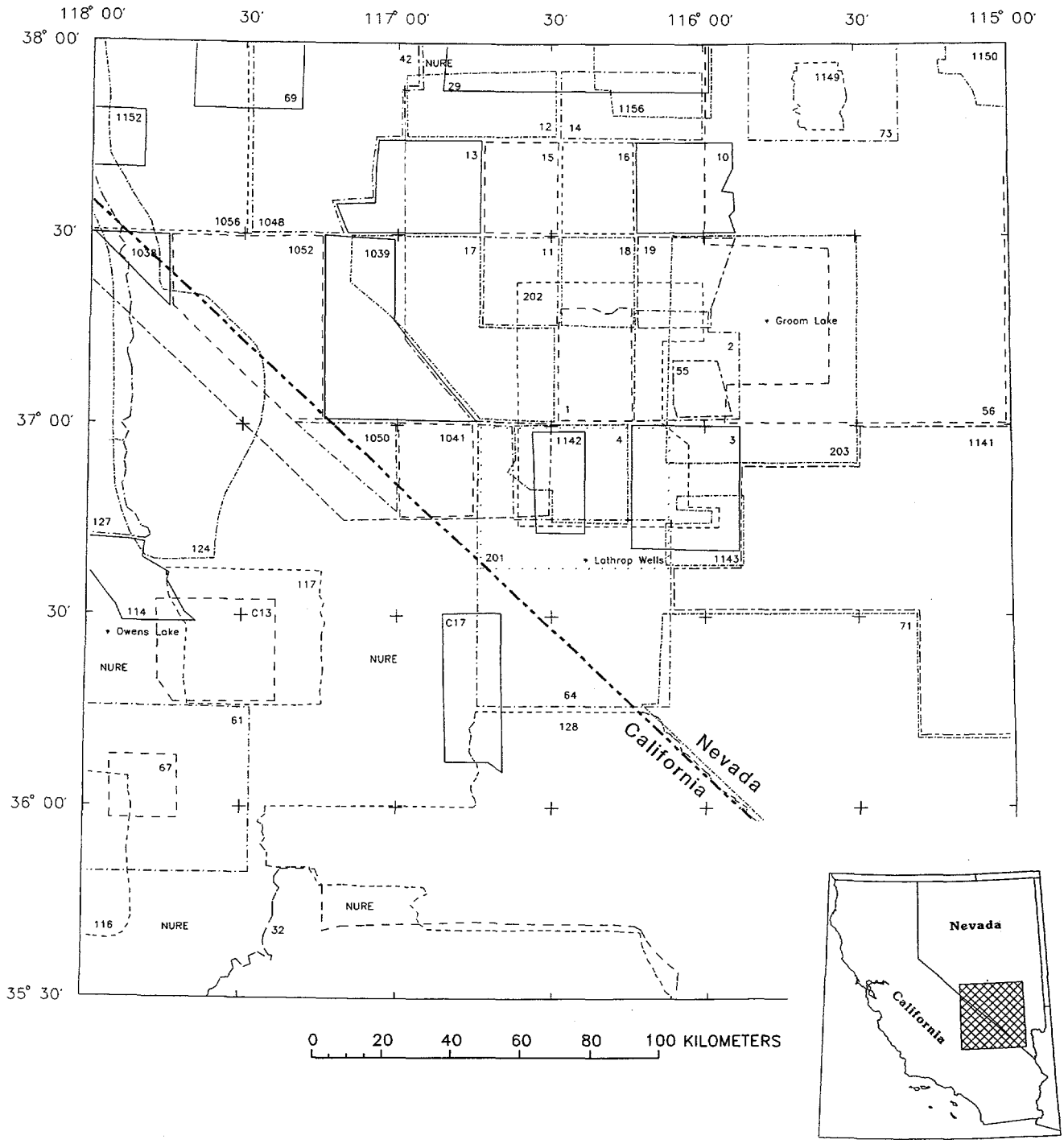

Figure 1. Index map showing locations and numbers of aeromagnetic surveys in study area. Surveys are isted in table 1. Coincident survey boundary lines have been offset for clarity. The numbers are nearest the coded boundary for each of the 50 plus aeromagnetic surveys. Areas marked NURE are covered by U.S. Department of Energy, 1979a-f data.

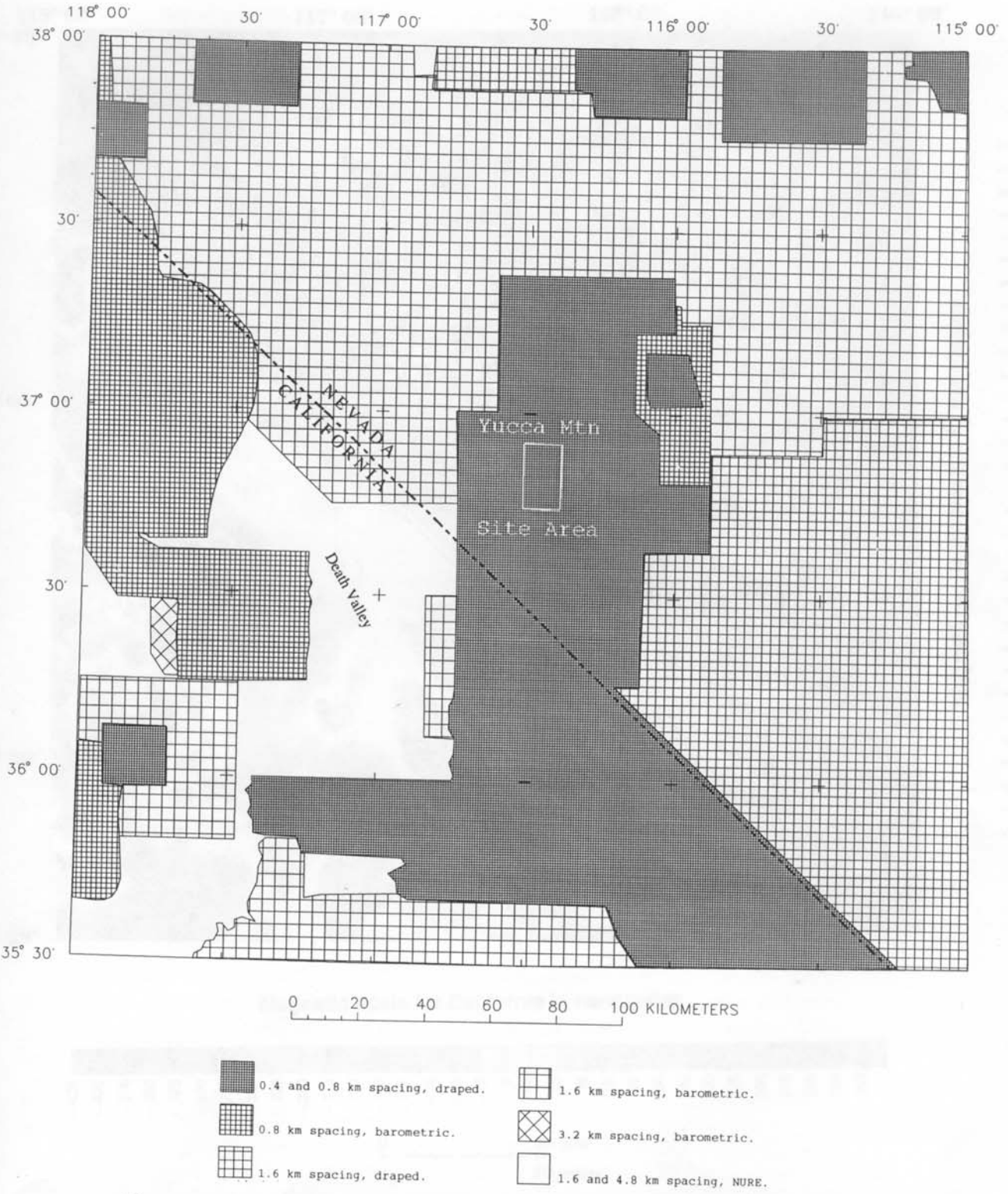

Figure 2. Index map of the aeromagnetic surveys for the Yucca Mountain area showing a summary of spacing (km=kilometers) and types of magnetic surveys (draped, barometric, and NURE (National Uranium Resource Evaluation surveys)). Surveys are listed in table 1 and shown on figure 1. [the boundary of the Yucca Mountain site is shown (U.S. Department of Energy, 1988)].

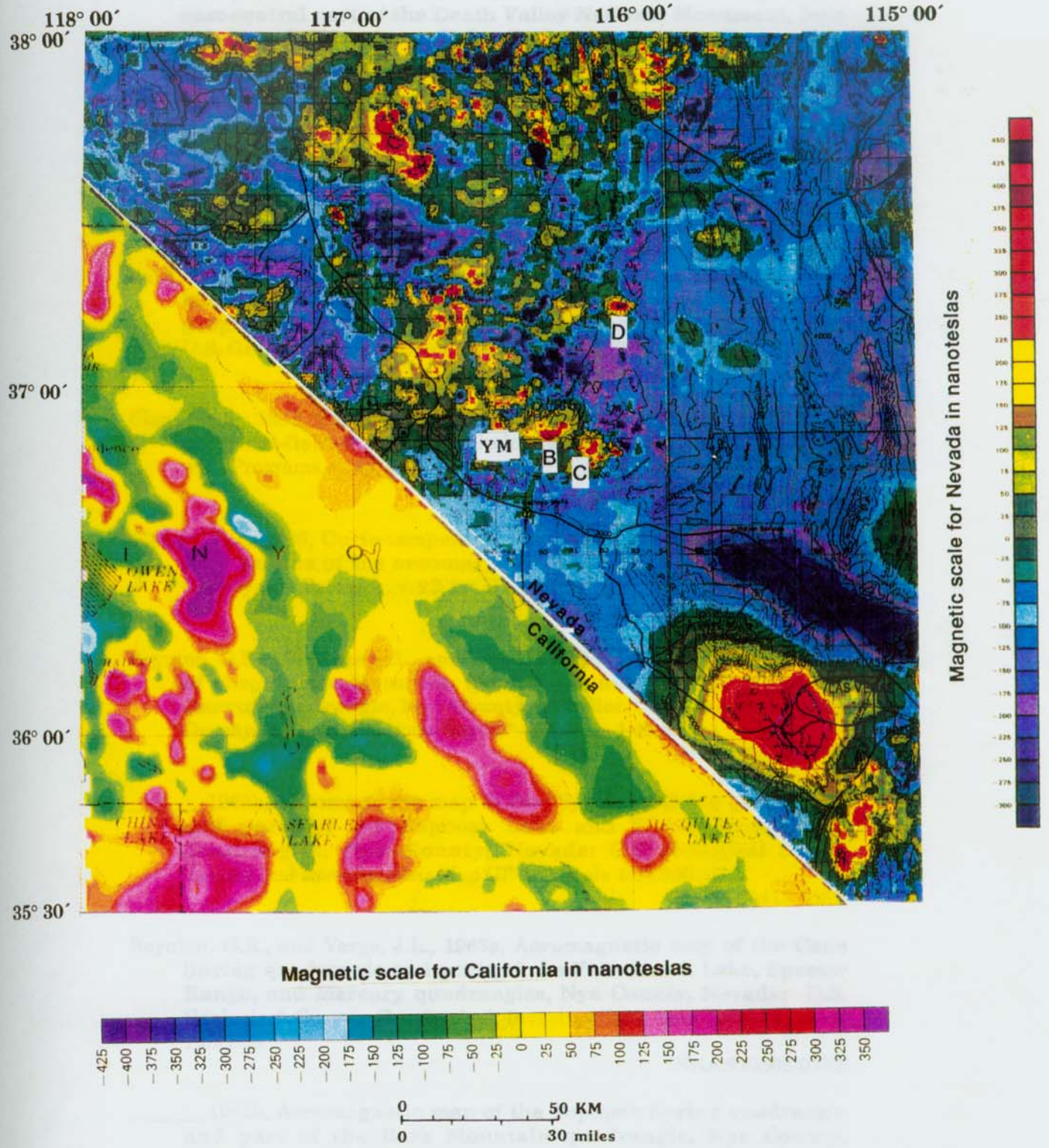

Figure 3. Residual total intensity aeromagnetic map of the southwestern Nevada and southeastern California centered on Yucca Mountain (YM). The California part of the map was compiled at a constant elevation 3.8 km above sea level (Hildenbrand and others, 1988). The part of Nevada was compiled at 305 m above ground (Hildenbrand and Kucks, 1988). Contour interval 25nT. Magnetic highs referred to in text are YM, Yucca Mountain; B, Calico Hills; C, Wahmonie; D, Climax stock.

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NOTE: Parenthesized numbers following each cited reference are for U.S. Department of Energy Office of Civilian Radioactive Waste Management Records Management purposes only and should not be used when ordering the publication.

Table 1.-Aeromagnetic surveys all or partly within Yucca Mountain regional study area

[Aero, Aero Service; AS, Aerial Surveys; Airmag, Airmag Surveys; AG, Applied Geophysics Inc.; b,constant barometric elevation; d,drape flown at constant altitude above ground; E, east; Elev, elevation; HLQEB, High-Life QEB; IGRF, International Geomagnetic Reference Field subtracted; km, kilometer; LKB, Lockwood, Kessler & Bartlett, Inc.; Mtn, Mountain; N, north; n.a., not available; Pk, Peak; POGO, Polar Orbiting Geophysical Observatory Data; S, south; USGS, U.S. Geological Survey; USNOO, US Naval Oceanographic Office; W, west]

N E V A D A [1]

Area	Name	Year flown	Flown by	Elevation (km)	Spacing (km)	Direction	Scale	Gradient removed	Digital	Reference
1	Timber Mtn	1960, 1961	USGS	2.4 b	0.4	E-W	1:62,500	no	no	Boynton and others, 1963a
2	Tippipah Spring	1960, 1961	USGS	2.4 b	0.4	E-W	1:62,500	no	no	Boynton and others, 1963b
3	Cane Spring	1961	USGS	2.4 b	0.4	E-W	1:62,500	no	no	Boynton and Vargo, 1963a
4	Topopah Spring	1961	USGS	2.4 b	0.4	E-W	1:62,500	no	no	Boynton and Vargo, 1963b
10	Belted Peak	1963	USGS	2.4 b	1.6	E-W	1:62,500	no	no	Philbin and White, 1965a
11	Black Mtn	1963	USGS	2.4 b	1.6	E-W	1:62,500	no	no	Philbin and White, 1965b
12	Cactus Peak	1963	USGS	2.4 b	1.6	E-W	1:62,500	no	no	Philbin and White, 1965c
13	Cactus Spring	1963	USGS	2.4 b	1.6	E-W	1:62,500	no	no	Philbin and White, 1965d
14	Kawich Peak	1963	USGS	2.4 b	1.6	E-W	1:62,500	no	no	Philbin and White, 1965e
15	Mellan	1963	USGS	2.4 b	1.6	E-W	1:62,500	no	no	Philbin and White, 1965f
16	Quartzite Mtn	1963	USGS	2.4 b	1.6	E-W	1:62,500	no	no	Philbin and White, 1965g
17	Sarcobatus Flat	1963, 1960	USGS	2.4 b	1.6	E-W	1:62,500	no	no	Philbin and White, 1965h
18	Silent Canyon	1963	USGS	2.4 b	0.8-1.6	E-W	1:62,500	no	no	Philbin and White, 1965i
19	Wheelbarrow Pk	1963 1960	USGS	2.4 b	0.8-1.6	E-W	1:62,500	no	no	Philbin and White, 1965j
29	Hot Creek	1966, 1967	Aero	0.12 d 0.3 d	1.6	E-W	1:250,000	no	no	USGS, 1968
42	Goldfield (map)	1967	LKB	2.7 b 4.6 b	1.6	E-W	1:250,000	no	no	USGS, 1971
55	Intermountain (Yucca Flats)	1971	USGS	0.12 d	0.4	E-W	1:26,000 1:165,000 1:198,000	no	no	Bath, 1976
56	Caliente, Lund	1973	USGS	2.7 b	1.6	N-S	1:125,000	no	no	USGS, 1976a
64	Lathrop Wells	1978	Aero	S 0.12 d N 0.3 d	0.4-0.8 0.8	E-W N-S	1:62,500	IGRF	yes	USGS, 1978
69	Lone Mtn	1979	AS	0.3 d	0.8	E-W	1:62,500	IGRF	yes	USGS, 1979a
71	S Nevada	1978	AS	0.3 d	1.6	E-W	1:250,000	IGRF	yes	USGS, 1979b
73	Quinn Canyon	1978	AS	0.3 d	0.8	E-W	1:62,500	IGRF	yes	USGS, 1979c
201	Yucca Mtn (map)	1977, 1978	AS, AG	0.12 d 0.3 d	0.4 0.8	E-W N-S	1:48,000 1:48,000	IGRF IGRF	yes yes	Kane and Bracken, 1983 Kane and others, 1981
202	Timber Mtn	1977	AG	0.12 d	0.4	E-W	1:62,500	IGRF	yes	USGS, 1979d
203	Groom Lake, Climax Stock	1980	USNOO	2.3 b 2.6 b	1.6 1.6	E-W E-W	1:250,000	IGRF	yes	Bath and others, 1983

Table 1 continued

Area	Name	Year flown	Flown by	Elevation (km)	Spacing (km)	Direction	Scale	Gradient removed	Digital	Reference
1038	Blanco, Soldier, Waucoba	1967	LKB	2.7 b	1.6	E-W	1:62,500	no	no	USGS, 1967b
1039	Bonnie Claire	1967	LKB	2.7 b	1.6	E-W	1:62,500	no	no	USGS, 1967a
1041	Bullfrog, Bare Mtn	1967	LKB	2.7 b	1.6	E-W	1:62,500	no	no	USGS, 1967c
1048	Goldfield	1967	LKB	2.7 b	1.6	E-W	1:62,500	no	no	USGS, 1967d
1050	Grapevine Peak, Tin Mtn	1967	LKB	2.7 b	1.6	E-W	1:62,500	no	no	USGS, 1967e
1052	Magruder Mtn	1967	LKB	2.7 b	1.6	E-W	1:62,500	no	no	USGS, 1967f
1056	Rhyolite Ridge	1967	LKB	2.7 b	1.6	E-W	1:62,500	no	no	USGS, 1967g
1141	Las Vegas	1983	HLQEB	0.3 d	1.6	E-W	1:250,000	IGRF	yes	USGS, 1983a
1142	Yucca Mtn	1982	HLQEB	0.12 d	0.4	N-S	1:62,500	IGRF	yes	USGS, 1984a
1143	Mercury	1982	HLQEB	0.12 d	0.4	E-W	1:62,500	IGRF	yes	USGS, 1984b
1149	Worthington Mtn	1985	Airmag	0.3 d	0.8	E-W	1:62,500	IGRF	yes	USGS, 1985a
1150	Seaman Range	1985	Airmag	0.3 d	0.8	E-W	1:62,500	IGRF	yes	USGS, 1985b
1152	Piper Peak	1985	Airmag	0.3 d	0.8	E-W	1:62,500	IGRF	yes	USGS, 1985c
1156	Reveille Range	1985	Airmag	0.3 d	0.8	E-W	1:62,500	IGRF	yes	USGS, 1985d

C A L I F O R N I A[2]

Area	Name	Year flown	Flown by	Elevation (km)	Spacing (km)	Direction	Scale	Gradient removed	Digital	Reference
c13	Darwin	n.a.	n.a.	3.0 b	3.2	E-W	1:333,000	no	no	Mabey, 1961
c17	Death Valley	1957	USGS	2.1 b	1.6	N-S	1:62,500	no	no	Andreasen and Petrafeso, 1963
32	Antelope Valley	1957	USGS	0.23 d	1.6	SE-NW	1:250,000	no	no	USGS, 1970
		1953	USGS	0.9 b	1.6	E-W	1:250,000	no	no	
		1967	USGS	1.8 b	1.6	E-W	1:250,000	no	no	
61	Coso Hot Spring	1975	AS	2.1 b	1.6	N-S	1:62,500	POGO	yes	USGS, 1976b
67	Coso Hot Spring	1977	AS	0.23 d	0.4	N-S	1:50,000	n.a.	yes	Fox, 1978
114	Owens Lake	1981	HLQEB	3.4 b	0.8	E-W	1:62,500	IGRF	yes	USGS, 1982a
116	Sierra Owens	1981	HLQEB	2.7 b	0.8	E-W	1:62,500	IGRF	yes	USGS, 1982b
117	Panamint Dunes	1981	HLQEB	2.1 b	0.8	E-W	1:62,500	IGRF	yes	USGS, 1982c
124	Eureka Valley Saline Valley	1981	HLQEB	2.1 b	0.8	E-W	1:250,000	IGRF	yes	USGS, 1983b
127	White/Inyo Mtn	1981	HLQEB	4.3 b	0.8	E-W	1:250,000	IGRF	yes	USGS, 1983c
128	Kingman-Trona	1981	HLQEB	0.3 d	0.8	E-W	1:250,000	IGRF	yes	USGS, 1983d

[1]Modified from Erwin and others, 1980; Hill, 1986

[2] Modified from Hill, 1986