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COMPLETE BOUGUER GRAVITY MAP OF THE NEVADA TEST SITE AND VICINITY, NEVADA

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GRAVITY ANOMALY CONTOUR INTERVAL 2 MGAL

ELEVATION CONTOUR INTERVAL 50 METERS

SCALE 1:100 000

1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS
1 0 1 2 3 4 5 MILES
5000 0 5000 10000 15000 20000 25000 FEET

Base from U.S. Geological Survey 1:100,000
Indian Springs, 1976; Beatty, Pahranagat Range, 1978; Pahute Mesa, 1979

INDEX MAP SHOWING AREA OF STUDY

EXPLANATION

GRAVITY ANOMALY CONTOURS
Contour interval 2 and 10 mGal. Hachures indicate gravity low. Contours were computer generated based on a 250-meter grid interpolated from scattered gravity data. Although the data have been edited, caution should be exercised when interpreting anomalies controlled by only a single data point.

GRAVITY STATION

GRAVITY BASE STATION

HIGH PRECISION GRAVITY STATION

ABSOLUTE GRAVITY STATION

PRELIMINARY AREA OF A POTENTIAL HIGH-LEVEL WASTE REPOSITORY AT YUCCA MOUNTAIN
(U.S. Department of Energy, 1984, p. 3-18)

AREAS OF POOR GRAVITY STATION CONTROL
Areas where the station density is generally less than 1 station per 2 by 2 km and 2 stations per 3 by 3 km. Although not shaded, additional control may be needed in areas that are geophysically or geologically complex.

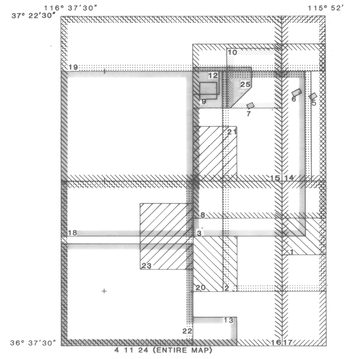

FIGURE. 1.–Index of NTS gravity maps (see table 1).

TABLE 1.–*List of NTS gravity maps for figure 1*

No.	Reference	No.	Reference
1.	Carr and others, 1975	14.	Healey and others, 1981a
2.	Diment and others, 1960	15.	Healey and others, 1981b
3.	Healey, 1966	16.	Healey and others, 1980
4.	Healey, 1968	17.	Kane and others, 1979; Reidy and others, 1979
5.	Healey, 1969	18.	Kane and others, 1981
6.	Healey, 1970a	19.	Miller and others, 1974
7.	Healey, 1970b	20.	Ponce, 1981
8.	Healey, 1976a	21.	Ponce and Hanna, 1982
9.	Healey, 1979	22.	Snyder and Carr, 1982
10.	Healey, 1983	23.	Snyder and Oliver, 1981
11.	Healey and Miller, 1962	24.	U.S. Geological Survey, 1968
12.	Healey and Miller, 1963	25.	Wahl, 1969
13.	Healey and Miller, 1971		

TABLE 2.–*Interpretative gravity reports of the Nevada Test Site and vicinity*

Geographic location	Reference
Calico Hills	Snyder and Oliver, 1981
Caliente 1° x 2° sheet	Snyder, 1983
Climax Stock	Healey, 1983
Frenchman Flat	Miller and Healey, 1986
Pahute Mesa	Healey, 1968
	Evans and Oliver, 1987
Southern Nevada-Regional	Anderson and others, 1965
	Diment and others, 1959
Southwestern Nevada Test Site	Snyder and Carr, 1984
Syncline Ridge	Ponce and Hanna, 1982
Timber Mountain	Healey and Miller, 1979
	Kane and others, 1981
Yucca Flat	Healey, 1968; 1969
North End	Healey, 1970a; 1970b; 1976a
Yucca Mountain	Healey and others, 1984
Yucca Mountain and Vicinity	Snyder and Carr, 1982
Wahmonie	Ponce, 1981; 1984

DISCUSSION

This map is based on about 15,000 gravity stations collected between 1956 and 1986 in conjunction with geologic studies at the Nevada Test Site (NTS). Principal facts of the gravity data are described by Harris and others (1989) and includes detailed descriptions of gravity base stations, the methods used to compute complete Bouguer anomaly values, and a discussion of gravity meters used and their calibration factors. Observed gravity values are referenced to the International Gravity Standardization Net 1971 gravity datum described by Morelli (1974). Free-air gravity anomalies were calculated by using the theoretical gravity based on the Geodetic Reference System 1967 formula for the normal gravity on the ellipsoid (International Association of Geodesy, 1971, p. 60) and Swick's formula (1942, p. 60) for the free-air correction. Bouguer, curvature, and terrain corrections for a standard reduction density of 2.67 g/cm^3 were added to the free air anomaly to determine complete Bouguer anomalies. Terrain corrections were made to a radial distance of 166.7 km from each station using a digital elevation model and a computer procedure by Plouff (1977) and include manually estimated inner-zone terrain corrections where available.

Gravity studies at the NTS were undertaken to help locate geologically favorable areas for underground nuclear tests and to help geologically characterize potential high-level nuclear waste storage sites. Figure 1 is an index of NTS gravity maps and the references for these maps are listed in table 1. Table 2 is a geographical summary of interpretive gravity reports at the NTS. Detailed data were obtained during the 1960's in Yucca and Frenchman Flats to help define the depth and configuration of the basement. The Silent Canyon caldera, approximately outlined by the -210 mGal contour in the northwest corner of the NTS was discovered under Pahute Mesa in the late 1960's based on gravity studies (Healey, 1968). Detailed gravity data near Syncline Ridge, Calico Hills, Wahmonie, and Yucca Mountain in the southwest quadrant of the NTS were collected to help assess these areas as potential high-level nuclear waste storage sites (Ponce and Hanna, 1982; Snyder and Oliver, 1981; Ponce, 1981; Snyder and Carr, 1982)

SOURCES OF GRAVITY DATA

Los Alamos National Laboratory (A. H. Cogbill, written commun., 1986)
National Geophysical Data Center (1984), and
U.S. Geological Survey:
- Healey (1976b)
- Healey and Curry (1977)
- Healey and others (1979)
- Healey, D. L. (written commun., 1985)
- Jansma and others (1982)
- Ponce (1981)
- Ponce and Hanna (1982)
- Reidy and others (1978)
- Snyder and Oliver (1981)
- Snyder and others (1981)

REFERENCES

Anderson, R. E., Ekren, E. B., and Healey, D. L., 1965, Possible buried mineralized areas in Nye and Esmeralda Counties, Nevada, in Geological Survey Research 1965: U.S. Geological Survey Professional Paper 525-D, p. D144-D150.

Carr, W. J., Bath, G. D., Healey, D. L., and Hazlewood, R. M., 1975, Geology of northern Frenchman Flat, Nevada Test Site: U.S. Geological Survey Report USGS-474-216, 23 p.

Diment, W. H., Healey, D. L., and Roller, J. C., 1959, Gravity and seismic exploration in Yucca Valley, Nevada Test Site–January-April, 1959: U.S. Geological Survey Trace Elements Investigations Report, TEI-545, 41 p.

— — —, 1960, Gravity and seismic exploration at the Nevada Test Site, in Short Papers in the Geological Sciences: U.S. Geological Survey Professional Paper 400-B, p. B156-B160.

Evans, J. R., and Oliver, H. W., 1987, Comparison of Timber Mountain Caldera complex, Nevada, with Yellowstone: Speculations on mechanism, in Decker, R. W., ed., Hawaii symposium on How Volcanoes Work, Hilo, Hawaii, January 19-25, 1987, Abstract Volume: University of Hawaii at Hilo, p. 67.

Harris, R. N., Healey, D. L., Ponce, D. A., and Oliver, H. W., 1989, Principal facts for about 15,000 gravity stations in the Nevada Test Site and vicinity: U.S. Geological Survey Open-File Report [in press].

Healey, D. L., 1966, Gravity and seismic study of Yucca Flat, Nevada Test Site, Nye County, Nevada, in Mining Geophysics, Case Histories, Society of Exploration Geophysicists, v. 1, p. 84-93.

— — —, 1968, Application of gravity data to geologic problems at Nevada Test Site, in Eckel, E.B., ed., Nevada Test Site: Geologic Society of America Memoir 110, p. 147-156.

— — —, 1969, Gravity survey of the Sturtevant Site, Nevada Test Site: U.S. Geological Survey Report USGS-474-59, 9 p.

— — —, 1970a, Gravity survey of the UE15j site, Area 15, Nye County, Nevada: U.S. Geological Survey Report USGS-474-66, 13 p.

— — —, 1970b, Gravity survey of Area 8, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Report USGS-474-89, 11 p.

— — —, 1976a, Interpretation of gravity surveys in intermontane basins of Nevada and New Mexico, in Site investigations methodology for multiple Aim point Missile Systems, AWFL-TR-76-145, Air Force Weapons Laboratory, Air Force Systems Command, Kirtland Air Force Base, New Mexico.

— — —, 1976b, Principal facts for gravity stations in the western part of the Goldfield 2 degrees sheet, in Nevada: U.S. Geological Survey Open-File Report 76-57, 15 p.

— — —, 1979, Gravity surveys–Rainier Mesa and U12n.10 tunnel, in U.S. Geological Survey investigations in connection with the Mighty Epic event, U12n.10 tunnel, Nevada Test Site: U.S. Geological Survey Report USGS-474-288, p. 154-166.

— — —, 1983, Gravity Investigations, in U.S. Geological Survey, Geologic and geophysical investigations of Climax Stock intrusive, Nevada: U.S Geological Survey Open-File Report 83-0377, 82 p.

Healey, D. L., Clutsom, F. G., and Glover, D. A., 1984, Borehole gravity meter surveys in drill holes USWG-3, UE-25pPS1, and UE- 25cPS1, in Yucca Mountain area, Nevada: U.S. Geological Survey Open-File Report 84-0672, 18 p.

Healey, D. L., and Currey, F. E., 1977, Principal facts for gravity stations in central Nevada, Nye, Esmeralda, Lander, Eureka, and White Pine Counties, Nevada: U.S. Geological Survey Open-File Report 77- 510, 87 p.

Healey, D. L., and Miller, C. H., 1962, Gravity survey of the Nevada Test Site and vicinity, Nye, Lincoln, and Clark Counties, Nevada–interim report: U.S. Geological Survey Trace Elements Investigations Report, TEI- 827, 36 p., 1 plate.

— — —, 1963, Gravity survey of the Gold Meadows stock, Nevada Test Site, Nye County, Nevada, in Short Papers in Geology and Hydrology: U.S. Geological Survey Professional Paper 475-B, p. 64-66.

— — —, 1971, Gravity survey of the Amargosa Desert area of Nevada and California: U.S. Geological Survey Report USGS-474-136, 29 p.

— — —, 1979, Interpretation of gravity data in the Timber Mountain area of the Nevada Test Site: U.S. Geological Survey Report USGS-474-308, 47 p.

Healey, D. L., Snyder, D. B., Wahl, R. R., and Currey, F. E., 1981a, Bouguer gravity map of Nevada, Caliente sheet: Nevada Bureau of Mines and Geology Map 70, scale 1:250,000.

Healey, D. L., Wahl, R. R., Currey, F. E., and Stephens, W. E., 1979, Complete Bouguer gravity map of the Caliente 1° x 2° sheet, Nevada and Utah: U.S. Geological Survey Report USGS-474-305, 75 p., scale 1:250,000.

Healey, D. L., Wahl, R. R., and Currey, F. E., 1981b, Principal facts, accuracies, sources, and base station descriptions for gravity stations in the Nevada part of the Goldfield and Mariposa 2 degree sheets: U.S. Geological Survey Report USGS-474-311, 12 p.

Healey, D. L., Wahl, R. R., and Oliver, H. W., 1980, Bouguer gravity map of Nevada, Death Valley sheet: Nevada Bureau of Mines and Geology Map 69, scale 1:250,000.

International Association of Geodesy, 1971, Geodetic Reference System 1967: International Association of Geodesy Special Publication no. 3, 116 p.

Jansma, P. E., Snyder, D. B., and Ponce, D. A., 1982, Principal facts of gravity stations with gravity and magnetic profiles from the southwest Nevada Test Site, Nye County, Nevada, as of January, 1982: U.S. Geological Survey Open-File Report 82-1041, 43 p.

Kane, M. F., Healey, D. L., Peterson, D. L., Kaufman, H. E., and Reidy, D., 1979, Bouguer gravity map of Nevada, Las Vegas sheet: Nevada Bureau of Mines and Geology Map 61, scale 1:250,000.

Kane, M. F., Webring, M. W., and Bhattacharyya, B. K., 1981, A preliminary analysis of gravity and aeromagnetic surveys of the Timber Mountain area, southern Nevada: U.S. Geological Survey Open-File Report 81-189, 40 p.

Miller, C. H., and Healey, D. L., 1986, Gravity interpretation of Frenchman Flat and vicinity, Nevada Test Site: U.S. Geological Survey Open-File Report 86-211, 44 p.

Miller, C. H., Healey, D. L., and Currey, F. E., 1974, Gravity map of the northern Nellis Air Force Bombing and Gunnery Range, Nevada: U.S. Geological Survey Geophysical Investigations Map GP-902, scale 1:125,000.

Morelli, C., ed., 1974, The International Gravity Standardization Net 1971: International Association of Geodesy Special Publication No. 4, 194 p.

National Geophysical Data Center, 1984, Defense Mapping Agency gravity file of the U.S.: available from National Geophysical Data Center, National Oceanic and Atmospheric Administration, Code E/Gex2, 325 Broadway, Boulder, CO 80303, 2 tapes.

Plouff, Donald, 1977, Preliminary documentation for a FORTRAN program to compute gravity terrain corrections based on topography digitized on a geographic grid: U.S. Geological Survey Open-File Report 77-535, 45 p.

Ponce, D. A., 1981, Preliminary gravity investigations of the Wahmonie Site, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Open-File Report 81-522, 64 p., 1 plate.

Ponce, D. A., 1984, Gravity and magnetic evidence for a granitic intrusion near Wahmonie Site, Nevada Test Site, Nevada: Journal of Geophysical Research, v. 89, no. B11, p. 9,401-9,413.

Ponce, D. A. and Hanna, W. F., 1982, Preliminary appraisal of gravity and magnetic data at Syncline Ridge, western Yucca Flat, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Open-File Report 82-931, 19 p.

Reidy, D., Kane, M. F., Healey, D. L., Peterson, D. L., and Kaufman, H. E., 1978, Principal facts for a set of regional gravity data for the Las Vegas 1 x 2 degree sheet, Nevada: U.S. Geological Survey Open-File Report 78-1012, 36 p.

— — —, 1979, Complete Bouguer gravity map of the Las Vegas 1 degree by 2 degrees sheet, Nevada: U.S. Geological Survey Open-File Report 79-531, scale 1:250,000.

Snyder, D. B., 1983, Interpretation of the Bouguer gravity map of Nevada, Caliente sheet: Nevada Bureau of Mines and Geology Report 37, 8 p.

Snyder, D. B., and Carr, W. J., 1982, Preliminary results of gravity investigations at Yucca Mountain and vicinity, southern Nye County, Nevada: U.S. Geological Survey Open-File Report 82-701, 36 p.

— — —, 1984, Interpretation of gravity data in a complex volcanotectonic setting, southwestern Nevada: Journal of Geophysical Research, v. 89, no. B11, p. 10,193-10,206.

Snyder, D. B., and Oliver, H. W., 1981, Preliminary results of gravity investigations of the Calico Hills, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Open-File Report 81-101, 42 p.

Snyder, D. B., Tang, R. W., Oliver, H. W., and Morin, R. L., 1981, Principal facts, accuracies, sources, base station descriptions, and plots for 2,255 new and revised gravity stations in the western half of the Caliente 1 x 2 degree quadrangle, Nevada and Utah: available from National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22152, PB81-1780, 101 p.

Swick, C. H., 1942, Pendulum gravity measurements and isostatic reductions: U.S. Coast and Geodetic Survey Special Publication 232, 82 p.

U.S. Department of Energy, 1984, Draft Environmental Assessment–Yucca Mountain Site, Nevada Research and Development Area, Nevada: U.S. Department of Energy Report DOE/RW-0012.

U.S. Geological Survey, 1968, Transcontinental geophysical survey (35-39W), Bouguer gravity map from 112 W longitude to the Coast of California: U.S. Geological Survey Miscellaneous Investigations Map I-532-8.

Wahl, R. R., 1969, An analysis of gravity data in Area 12, Nevada Test Site: U.S. Geological Survey Open-File Report 69-1289, 23 p., 3 plates.