

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

**GRAVITY OBSERVATIONS IN THE EASTERN PART OF THE  
ELY 1 BY 2 DEGREE QUADRANGLE, NEVADA**

By

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## INTRODUCTION

A gravity survey was conducted in July, 1986 by the U.S. Geological Survey as part of a continuing effort to produce a complete Bouguer gravity map of the Ely 1 by 2 degree quadrangle, Nevada. The project is a joint cooperative study with the Nevada Bureau of Mines and Geology. The Ely quadrangle is located on the eastern edge of north-central Nevada between 39° and 40° north latitude and 114° and 116° west longitude.

The principal facts for about 80 gravity stations in the eastern part of the Ely quadrangle are described. Gravity observation were made with LaCoste and Romberg gravity meter G-17 with a calibration factor, in addition to the factory calibration tables, of 1.0025. The calibration factor was determined by making gravity observations on an established gravity meter calibration loop in California (see Ponce and Oliver, 1981). All gravity stations have been terrain corrected to 166.7 km and reduced to complete Bouguer anomalies.

## GRAVITY METHODS

### GENERAL

Standard gravity corrections were made on all the data and include: (a) the Earth-tide, (b) the instrument drift, (c) the free-air, (d) the Bouguer, (e) the latitude, (f) the curvature, and (g) the terrain correction. Theoretical gravity is based on the Geodetic Reference System of 1967 (International Union of Geodesy and Geophysics, 1971) and observed gravity values are referenced to the International Gravity Standardization Net 1971 (IGSN 71) observed gravity datum described by Morelli (1974, p. 18).

### BASE STATIONS

Gravity data were tied to the same base station at the beginning and end of each day. All

gravity data were ultimately tied to primary gravity base ELYA, at the Ely Airport, Nevada. ELYA is part of the World Relative Gravity Reference Network described by Jablonsky (1974) and has an IGSN 71 observed gravity value of 979480.08 mGal.

## ELEVATION CONTROL

Gravity measurements were made on bench marks or at *spot-elevations*. In general, bench marks are considered accurate to about  $\frac{1}{2}$  meter, and spot-elevations are considered accurate to about 3 meters. A 3-meter uncertainty in elevation results in a Bouguer anomaly uncertainty of about 0.60 mGal, a value within the allowable error for regional gravity studies.

## TERRAIN CORRECTIONS

Terrain corrections were made in a three-part process: (a) the field correction, (b) the inner-zone correction, and (c) the outer-zone correction. The Hayford-Bowie system of zones and compartments was used to estimate terrain corrections (Hayford and Bowie, 1917). The field terrain correction was estimated from the station to a radial distance of 68 meters (zone B) using tables and charts or sketched and later estimated in the office.

The inner-zone terrain correction was made by placing a transparent template, made up of concentric rings and radial lines, on the largest scale topographic map available and centered at the gravity station. The template's rings divide the topography into lettered zones and the radial lines divide each zone into equal-size compartments. Terrain corrections were calculated by estimating *average* compartment elevations and using a program by Spielman and Ponce (1984). Inner-zone corrections were made from a radial distance of 68 to 590 m (zones C and D).

The outer-zone terrain correction from 0.59 km (zone E) to a radial distance of 166.7 km (zone O) was calculated using a computer program by Plouff (1977) that utilizes digital

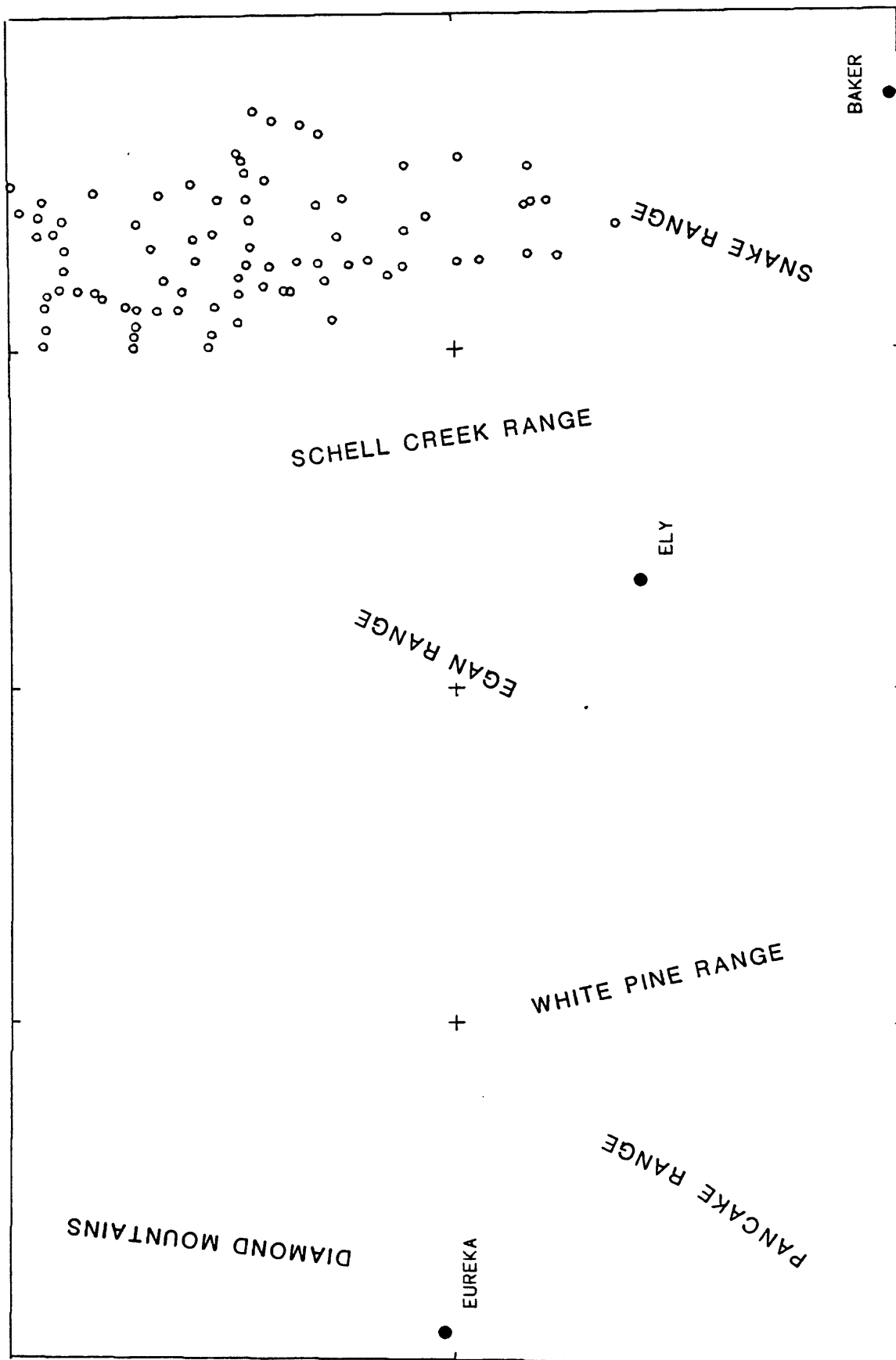
terrain data.

## **PRINCIPAL FACTS**

The locations of all the data are shown in figure 1. The format of the principal fact data is described in table 1. A four-digit accuracy code, as explained in table 2, has been assigned to each station describing the general location, elevation, latitude, and the observed gravity accuracies. The principal facts are listed in table 3.

114° 00'

116° 00'  
40° 00'



## REFERENCES

- Jablonski, H. M., 1974, World relative gravity reference network North America, Parts 1 and 2: U.S. Defense Mapping Agency Aerospace Center Reference Publication no. 25, originally published 1970, revised 1974, with supplement of IGSN 71 gravity datum values, 1261 p.
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- International Union of Geodesy and Geophysics, 1971, Geodetic Reference System 1967: International Association of Geodesy Special Publication no. 3, 166 p.
- Morelli, C. (Ed.), 1974, The International Gravity Standardization Net, 1971: International Association of Geodesy Special Publication no. 4, 194 p.
- Plouff, Donald, 1977, Preliminary documentation for a *FORTTRAN* 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., and Oliver, H. W., 1981, Charleston Peak gravity calibration loop, Nevada: U.S. Geological Survey Open-File Report 81-985, 20 p.
- Spielman, J. B., and Ponce, D. A., 1984, *Handtc*, a *FORTTRAN* program to calculate inner-zone terrain corrections: U.S. Geological Survey Open-File Report 84-777, 20 p.



TABLE 1.—*Explanation of principal fact format*

Item	Explanation
STATION NAME -----	An alphanumeric combination of up to 8 characters used for station identification
LAT -----	Latitude in degrees and minutes, to 0.01 minute
LON -----	Longitude in degrees and minutes, to 0.01 minute
ELEV -----	Elevation, to 0.1 feet
OG -----	Observed gravity, to 0.01 mGal
AC -----	Four digit code describing the general location, elevation, latitude, and observed gravity accuracy
FAA -----	Free-air anomaly to 0.01 mGal
SBA -----	Simple Bouguer anomaly reduced for a density of 2.67 g/cm <sup>3</sup> , to 0.01 mGal
ITC -----	Inner-zone terrain correction for a density of 2.67 g/cm <sup>3</sup> , to 0.01 mGal, followed by a letter denoting the extent of the correction in the Hayford-Bowie system of zones.
TC -----	Total terrain correction from 0.0 to 166.7 km for a density of 2.67 g/cm <sup>3</sup> , to 0.01 mGal
CBA -----	Complete Bouguer anomaly reduced for a density of 2.67 g/cm <sup>3</sup> , to 0.01 mGal
CBA -----	Complete Bouguer anomaly reduced for a density of 2.50 g/cm <sup>3</sup> , to 0.01 mGal

TABLE 2.—*Explanation of accuracy codes*

Code	Explanation	Elevation accuracy (ft)	Latitude accuracy (min)	Distance accuracy (ft)	Approximate gravity effect (mGal)
<b>General location code—1<sup>st</sup> digit</b>					
A	Altimetry, good control	—	—	—	—
B	Level line bench mark	—	—	—	—
C	Contour line interpolation	—	—	—	—
D	Destroyed or not found reference mark	—	—	—	—
G	Spot elevation, brown or not field checked	—	—	—	—
V	Vertical angle bench mark (VABM)	—	—	—	—
<b>Elevation code—2<sup>nd</sup> digit</b>					
1	On bench mark	0.2	—	—	0.01
2	Near bench mark	0.3	—	—	0.02
4	VABM and black map elevation	2.0	—	—	0.10
5	Black map elevation and good photogrammetry	4.0	—	—	0.20
6	Brown map elevation and good photogrammetry on 20 ft contour interval map	10.0	—	—	0.50
7	Brown map elevation on 80 ft contour interval map and good altimetry	20.0	—	—	1.20
8	Contour interpolation	40.0	—	—	2.40
<b>Latitude code—3<sup>rd</sup> digit</b>					
1	Triangulation or special survey data	—	0.0075	42	0.01
2	1:24,000-scale map with special location care	—	0.014	84	0.03
3	1:24,000- to 1:62,500-scale topographic maps	—	0.035	210	0.05
<b>Observed gravity code—4<sup>th</sup> digit</b>					
1	Local surveys with special gravity meters	—	—	—	0.01
2	Multiple observations with LaCoste and Romberg gravity meters	—	—	—	0.02
3	Average LaCoste and Romberg or multiple observations with Worden gravity meters	—	—	—	0.05
4	LaCoste and Romberg observations with small vibrations and average Worden gravity meters	—	—	—	0.10

TABLE 3.—Principal facts of gravity data

STATION NAME	LAT deg mm	LON deg mm	ELEV ft	OG mGal	AC	FAA mGal	SBA mGal	ITC mGal	TC mGal	CBA 2.67	CBA 2.50
AR001	39 46.82	114 29.70	6785.0	979518.65	G633	7.41	-224.01	0.09	D 1.27	-224.25	-209.50
AR002	39 46.40	114 28.59	6920.0	979513.14	G633	14.91	-221.11	0.27	D 1.96	-220.66	-205.66
AR003	39 44.80	114 27.50	6256.0	979555.13	G633	-2.83	-216.20	0.21	D 1.37	-216.34	-202.75
AR004	39 46.18	114 26.09	6090.0	979563.13	G633	-12.77	-220.49	0.12	D 1.66	-220.33	-207.11
AR005	39 48.35	114 24.69	6372.0	979559.38	G633	6.77	-210.56	0.09	D 1.54	-210.53	-196.70
AR006	39 48.64	114 26.39	6829.0	979532.29	G633	22.19	-210.73	0.55	D 3.49	-208.75	-194.05
AR007	39 49.61	114 23.71	6134.0	979576.04	G633	-0.81	-210.02	0.05	D 1.88	-209.64	-196.35
AR008	39 50.06	114 26.42	7076.0	979522.40	G633	33.40	-207.94	1.30	D 4.69	-204.77	-189.60
AR009	39 51.42	114 26.33	7835.0	979479.40	G633	59.70	-207.53	0.91	D 5.22	-203.79	-187.01
AR010	39 52.15	114 26.05	8651.0	979430.22	G633	86.10	-208.96	0.87	D 8.92	-201.45	-183.14
AR011	39 50.43	114 20.80	5660.0	979588.10	G633	-34.51	-227.56	0.01	D 1.31	-227.72	-215.42
AR012	39 47.58	114 19.96	5652.0	979583.36	G633	-35.78	-228.55	0.01	D 0.91	-229.11	-216.80
AR013	39 46.28	114 19.52	5678.0	979582.90	G633	-31.86	-225.52	0.01	D 1.00	-226.00	-213.64
AR014	39 47.44	114 21.90	5770.0	979595.12	G633	-12.72	-209.52	0.03	D 0.98	-210.02	-197.46
AR015	39 57.75	114 29.52	6954.0	979531.77	G633	19.90	-217.28	0.06	D 1.21	-217.59	-202.47
AR016	39 57.54	114 28.04	7162.0	979522.18	G633	30.17	-214.11	0.04	D 1.64	-213.98	-198.44
AR017	39 57.63	114 26.08	7678.0	979498.28	G633	54.61	-207.26	0.30	D 3.26	-205.49	-188.93
AR018	39 57.43	114 24.99	8641.0	979438.43	G633	85.54	-209.18	0.50	D 8.01	-202.58	-184.23
AR019	39 56.59	114 24.39	7789.0	979493.15	G633	61.46	-204.21	0.97	D 5.13	-200.56	-183.88
AR020	39 55.38	114 24.55	8631.0	979438.01	G633	87.22	-207.16	0.79	D 7.87	-200.70	-182.37
AR021	39 53.72	114 25.28	9020.0	979404.91	G633	93.12	-214.53	0.22	D 10.05	-205.83	-186.80
AR022	39 54.23	114 24.70	8886.0	979418.97	G633	93.83	-209.24	0.56	D 9.52	-201.10	-182.32
AR023	39 56.31	114 22.70	7080.0	979533.88	G633	35.98	-205.50	1.30	D 5.66	-201.35	-186.24
AR024	39 56.24	114 20.91	6447.0	979566.45	G633	9.18	-210.71	0.24	D 3.32	-208.90	-195.02
AR025	39 56.39	114 18.25	5830.0	979599.46	G633	-16.02	-214.86	0.04	D 1.21	-215.14	-202.46
AR026	39 59.27	114 17.44	5839.0	979606.34	G633	-12.57	-211.72	0.06	D 0.92	-212.29	-199.57
AR027	39 59.81	114 15.08	5958.0	979606.45	G633	-2.07	-205.28	0.05	D 0.66	-206.11	-193.12
AR028	39 57.72	114 16.51	5730.0	979604.17	G633	-22.68	-218.11	0.02	D 0.76	-218.83	-206.34
AR029	39 57.97	114 17.87	5866.0	979600.11	G633	-14.33	-214.40	0.06	D 1.08	-214.81	-202.05
AR030	39 58.06	114 19.53	6251.0	979579.83	G633	1.44	-211.77	0.22	D 2.09	-211.18	-197.65
AR031	39 56.97	114 19.38	6092.0	979586.00	G633	-5.72	-213.50	0.14	D 1.91	-213.09	-199.88
AR032	39 54.28	114 15.71	5684.0	979592.99	G633	-33.08	-226.94	0.06	D 0.69	-227.73	-215.34
AR033	39 51.67	114 29.76	7085.0	979514.66	G633	24.12	-217.52	0.10	D 1.69	-217.35	-201.97
AR034	39 51.62	114 28.77	7290.0	979508.60	G633	37.40	-211.25	0.27	D 2.41	-210.34	-194.57
AR035	39 51.49	114 27.83	7579.0	979493.98	G633	50.13	-208.37	0.41	D 3.39	-206.48	-190.14
AR036	39 44.53	114 24.93	5866.0	979574.53	G633	-19.98	-220.05	0.01	D 0.84	-220.70	-207.92
AR037	39 44.53	114 23.45	5906.0	979583.76	G633	-6.99	-208.43	0.09	D 0.85	-209.07	-196.20
AR038	39 42.85	114 24.29	6077.0	979568.92	G633	-3.27	-210.53	0.10	D 0.98	-211.05	-197.82
AR039	39 41.49	114 24.67	6208.0	979558.73	G633	0.87	-210.87	0.14	D 0.92	-211.45	-197.93
AR040	39 41.04	114 24.71	6201.0	979558.39	G633	0.54	-210.96	0.08	D 0.83	-211.64	-198.13
AR041	39 38.73	114 23.79	6167.0	979552.71	G633	-4.92	-215.25	0.13	D 0.93	-215.83	-202.40
AR042	39 37.08	114 22.35	6100.0	979557.99	G633	-3.49	-211.54	0.09	D 0.90	-212.14	-198.86
AR043	39 39.16	114 22.20	6590.0	979527.86	G633	9.35	-215.41	0.07	D 1.19	-215.74	-201.41
AR044	39 40.58	114 22.03	6456.0	979540.13	G633	6.93	-213.27	0.62	D 1.75	-213.03	-199.03
AR045	39 42.46	114 22.45	6054.0	979571.22	G633	-2.55	-209.03	0.13	D 1.02	-209.51	-196.33
AR046	39 43.99	114 22.31	5827.0	979587.33	G633	-10.04	-208.78	0.07	D 0.96	-209.31	-196.62
AR047	39 43.73	114 20.70	5834.0	979579.93	G633	-16.40	-215.38	0.05	D 1.01	-215.86	-203.16
AR048	39 43.79	114 18.29	6129.0	979572.13	G633	3.44	-205.60	0.17	D 2.16	-204.94	-191.68
AR049	39 43.96	114 16.42	6610.0	979537.63	G633	13.89	-211.56	0.21	D 4.33	-208.74	-194.57
AR050	39 45.94	114 16.47	6055.0	979578.58	G633	-0.25	-206.77	0.07	D 2.16	-206.11	-193.00
AR051	39 47.70	114 15.03	6033.0	979582.33	G633	-1.18	-206.95	0.03	D 1.33	-207.12	-194.00
AR052	39 49.89	114 15.99	5799.0	979596.39	G633	-12.36	-210.15	0.02	D 0.83	-210.80	-198.17
AR053	39 51.41	114 18.57	5624.0	979583.43	G633	-44.02	-235.84	0.01	D 0.96	-236.35	-224.10
AR054	39 38.24	114 27.36	5820.0	979566.05	G633	-23.46	-221.96	0.01	D 0.78	-222.67	-209.98
AR055	39 35.78	114 21.95	5885.0	979566.71	G633	-13.05	-213.77	0.03	D 0.86	-214.40	-201.58
AR056	39 37.88	114 19.81	6189.0	979549.06	G633	-5.24	-216.33	0.07	D 1.11	-216.72	-203.26
AR057	39 39.25	114 16.95	6646.0	979526.42	G633	13.04	-213.63	0.07	D 1.20	-213.95	-199.50
AR058	39 42.72	114 14.74	7762.0	979462.94	G633	49.28	-215.46	0.28	D 4.69	-212.25	-195.60
AR059	39 44.07	114 14.08	8291.0	979441.11	G633	75.15	-207.63	0.29	D 7.09	-201.98	-184.34
AR060	39 44.26	114 12.99	7614.0	979472.85	G633	43.01	-216.69	1.28	D 5.71	-212.47	-196.21
AR061	39 44.59	114 12.32	7492.0	979488.44	G633	46.64	-208.89	0.37	D 3.72	-206.67	-190.54
AR062	39 43.45	114 8.62	6779.0	979533.02	G633	25.91	-205.30	0.07	D 2.40	-204.42	-189.75
AR063	39 42.17	114 9.45	7239.0	979496.67	G633	34.69	-212.22	0.13	D 2.93	-210.80	-195.17
AR064	39 40.26	114 9.81	7914.0	979450.12	G633	54.39	-215.54	0.40	D 4.56	-212.46	-195.47
AR065	39 39.03	114 10.62	7598.0	979470.41	G633	46.81	-212.34	0.16	D 2.77	-211.07	-194.65
AR066	39 37.48	114 16.38	6558.0	979521.07	G633	2.04	-221.63	0.06	D 1.04	-222.11	-207.84
S R001	39 33.29	114 13.51	6959.0	979500.02	G633	24.87	-212.48	0.05	D 1.32	-212.67	-197.55
S R002	39 29.66	114 12.78	7257.0	979479.96	G633	38.19	-209.32	0.08	D 2.29	-208.54	-192.83
S R003	39 24.99	114 13.61	8465.0	979398.79	G633	77.43	-211.29	0.58	D 6.01	-206.71	-188.62
S R004	39 25.25	114 17.06	9492.0	979323.92	G633	98.65	-225.10	1.49	D 16.15	-210.23	-190.56

TABLE 3.-Principal facts of gravity data-Continued

STATION NAME	LAT deg min	LON deg min	ELEV ft	OG mGal	AC	FAA mGal	SBA mGal	ITC mGal	TC mGal	CBA 2.67	CBA 2.50
SR005	39 24.79	114 16.76	9262.0	979343.15	G633	96.95	-218.95	0.72 D	11.31	-208.95	-189.48
SR006	39 23.75	114 16.67	9267.0	979340.70	G633	96.51	-219.56	2.27 D	13.75	-207.13	-187.79
SR007	39 23.05	114 21.58	5600.0	979560.64	G633	-27.07	-218.07	0.03 D	3.08	-216.45	-204.40
SR008	39 33.45	114 22.54	5705.0	979572.73	G633	-20.49	-215.07	0.03 D	1.09	-215.46	-203.05
SR009	39 34.47	114 23.31	5723.0	979570.10	G633	-22.94	-218.13	0.02 D	0.88	-218.73	-206.27
SR010	39 31.86	114 18.07	6872.0	979501.72	G633	20.52	-213.87	0.19 D	3.17	-212.21	-197.39
SR011	39 33.34	114 19.30	6131.0	979550.36	G633	-2.66	-211.77	0.11 D	1.69	-211.59	-198.28
SR012	39 29.78	114 22.08	5771.0	979562.99	G633	-18.60	-215.43	0.08 D	2.85	-214.06	-201.62
SR013	39 28.27	114 21.95	5935.0	979550.90	G633	-13.04	-215.47	0.26 D	3.18	-213.78	-201.00
SR014	39 25.04	114 21.43	5799.0	979554.12	G633	-17.82	-215.61	0.10 D	3.31	-213.78	-201.30
SR015	39 19.11	114 18.78	6843.0	979483.76	G633	18.70	-214.70	1.17 D	6.40	-209.82	-195.27