

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

*Descriptions and Elevations for Bench Marks  
at Mammoth Lakes, California*

By

Kenneth M. Yamashita and David E. Wieprecht<sup>1</sup>

Open-File Report 91-630

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American Stratigraphic Code. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U. S. Government.

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Alphabetical listing of bench marks and page description

Bench mark ID	Page number	Bench mark ID	Page Number
CASA	07	20 JD	12
CVO89-300	16	JEE 1	10
CVO89-301	16	JEE 3	10
CVO89-302	15	JEE 6	10
CVO89-303	15	JEE 9	10
CVO89-304	14	JEE 12	10
CVO89-305	14	JEE 15	10
CVO89-306	14	JEE 17	11
CVO89-307	14	JEE 19	11
CVO89-308	13	JEE 20	11
CVO89-309	13	JEE 22	11
CVO89-310	13	34 EGE	06
CVO89-311	12	35 EGE	06
DBR 11	07	36 EGE	05
DBR 12	07	37 EGE	05
DBR 13	07	38 EGE	05
DBR 15	07	39 EGE	05
DBR 18	07	40 EGE	04
DBR 19	06	42 EGE	11
DBR 20	06	STA 907	04
DBR 21	06	RET	12
D 1383	12	VISTA 89	13
E 1383	09		
F 1383	08		
G 1383	08		
H 1383	08		
J 1383	08		
K 1383	04		
1 LRM	06		
2 LRM	06		
3 LRM	04		
2 JCM	05		
3 JCM	04		
5 JCM	08		
6 JCM	09		
7 JCM	09		
8 JCM	09		
9 JCM	11		

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## PURPOSE OF REPORT

This report describes new bench marks installed by the Cascades Volcano Observatory (CVO) leveling crew during the fall of 1989. In addition, improved descriptions are given for bench marks installed by the U.S. Geological Survey (USGS) in 1982, 1983, and 1985, and bench marks installed by the National Geodetic Survey (NGS) in 1986.

Included in this report are elevations for all bench marks recovered during the 1989 survey, and for the new marks installed by the CVO crew (table 1).

Also included is a partial reproduction of the U.S. Geological Survey topographic quadrangles, OLD MAMMOTH, CRYSTAL CRAG and MAMMOTH MTN, CA., with the locations of the bench marks plotted (figures 50 to 52).

Because of heavy snowfall at Mammoth Lakes, we felt photographs (figures 1 to 49) were needed to document the bench marks for recovery during winter months.

### Note:

Bench marks DBR 21 through DBR 11, which fall between 1 LRM and CASA and bench marks JEE 22 through JEE 1, which fall between bench marks 9 JCM and 8 JCM are not plotted on the map because of their close spacing.

## LEVELING SURVEY AND CORRECTIONS APPLIED TO THE DATA

The 1989 CVO leveling survey was conducted under the guidelines prescribed by the Federal Geodetic Control Committee (FGCC) (Federal Geodetic Control Committee, 1984, Yamashita and Kaiser, 1991) for First-Order, Class II level surveys.

All data were recorded in a Hewlett-Packard hand-held computer (Yamashita, 1989), which recorded all checks and balances. The data were archived in the field on a cassette recorder and later down-loaded into a mainframe computer in the office, and final corrections were applied.

Corrections applied to the data set were to compensate for: 1) index of refraction of the light path due to ambient temperature variations, 2) inaccuracy of the rod scales (our rods are calibrated yearly at each centimeter interval by the National Bureau of Standards in Gaithersburg, Maryland), and 3) the change in length of the invar strip due to temperature variations.

## ACKNOWLEDGEMENTS

The authors thank Elliot T. Endo and Eugene Y. Iwatsubo for their many helpful suggestions and comments during the review of this manuscript.

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CVO89-305	14	JEE 15	10
CVO89-306	14	JEE 17	11
CVO89-307	14	JEE 19	11
CVO89-308	13	JEE 20	11
CVO89-309	13	JEE 22	11
CVO89-310	13	34 EGE	06
CVO89-311	12	35 EGE	06
DBR 11	07	36 EGE	05
DBR 12	07	37 EGE	05
DBR 13	07	38 EGE	05
DBR 15	07	39 EGE	05
DBR 18	07	40 EGE	04
DBR 19	06	42 EGE	11
DBR 20	06	STA 907	04
DBR 21	06	RET	12
D 1383	12	VISTA 89	13
E 1383	09		
F 1383	08		
G 1383	08		
H 1383	08		
J 1383	08		
K 1383	04		
1 LRM	06		
2 LRM	06		
3 LRM	04		
2 JCM	05		
3 JCM	04		
5 JCM	08		
6 JCM	09		
7 JCM	09		
8 JCM	09		
9 JCM	11		

## APPENDIX I

### Descriptions of bench marks at Mammoth Lakes, California.

Mileage for the bench marks along the level line is referenced from bench mark K 1383 at the entrance to the Post Office at Mammoth Lakes, California. All distances are derived from stadia readings observed during the 1989 CVO survey.

- K 1383            At the entrance to the post office at Mammoth Lakes, California. Mark is a stainless-steel rod enclosed in a 12.7 cm (5 in.) diameter PVC pipe with a metal cap, 5.5 m (18 ft.) north of the center of the roadway, and 1.2 m (3.8 ft.) west of the west edge of a concrete wall with the sign "United States Post Office" (See figure 1). Stamping on the metal ring holding cap is "K 1383 1986".
- 3 JCM            1.08 km (0.65 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, then 0.1 km (0.05 mi.) north along the road to the Forest Service Ranger Station. Bench mark is a brass disc cemented on the top of a 2 X 2 m (6 x 6 ft.) embedded boulder projecting 1 m (3 ft.) above the ground level, 7 m (22 ft.) west of the center of the parking area exit lane, and 4 m (13 ft.) east of the walkway to the ranger station (See figure 2). Bench mark is stamped "3 JCM 1982". Note: New mortar was poured around the bench mark because of the poor condition of the original concrete.
- STA 907           1.59 km (1.0 mi.) east along the east-bound lane of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is welded on the top of a 5 cm (2 in.) diameter pipe projecting 20 cm. (8 in.) above the ground level, 12 m (40 ft.) south of the centerline of State Highway 203, and 0.6 m (2 ft.) south of a metal "Right of Way" post (See figure 3). Bench mark is stamped "907 54.65 77331".
- 3 LRM            1.67 km (1.05 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented at the east end of a 2 X 2 m (6 X 6 ft.) portion of a rock outcrop projecting 0.6 m (2 ft.) above the ground, 2 m (6 ft.) west of a witness post, 23 m (75 ft.) south of the center of State Highway 203, and "in line" with a "55" MPH speed sign. (See figure 4). Bench mark is stamped "3 LRM 1985". Note: New mortar was poured around the bench mark.
- 40 EGE           2.13 km (1.3 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on top of a 2 X 2 m (6 X 6 ft.) embedded boulder projecting 0.9

m (3 ft.) above ground level, 20 m (67 ft.) north of the centerline of the State Highway 203, and 12 m (40 ft.) northwest of "National Forest" sign (See figure 5). Bench mark is stamped "40 EGE 1983". Note: New mortar was poured around the bench mark.

- 39 EGE 2.48 km (1.55 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on the west end of a 3 X 5 m (10 X 16 ft.) boulder projecting 2 m (6 ft.) above the ground level, 40 m (130 ft.) south of the centerline of State Highway 203, and 19 m (63 ft.) east of the centerline of Meridian Blvd. (See figure 6). Bench mark is stamped "39 EGE 1983". Note: New mortar was poured around the bench mark.
- 2 JCM 2.80 km (1.7 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on the east end of a 6 X 6 m (20 X 20 ft.) by 2.4 m (8 ft.) high granite boulder, 101 m (331 ft.) south of the centerline of State Highway 203, and approximately 23 m (75 ft.) west of a 3 m (10 ft.) high snow fence (See figure 7). Bench mark is stamped "2 JCM 1983". Note: New mortar was poured around the bench mark.
- 38 EGE 3.04 km (1.9 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on a 2 X 3 m (6 X 9 ft.) embedded boulder projecting 0.15 m (0.5 ft.) above the ground level, 13 m (43 ft.) south of State Highway 203, and 2.0 m (6 ft.) south of a witness post (See figure 8). Bench mark is stamped "38 EGE 1983". Note: New mortar was poured around the bench mark.
- 37 EGE 3.27 km (2.05 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented in the top of a 0.75 X 1 m (2 X 3 ft.) embedded boulder projecting 0.3 m (1 ft.) above ground level, 18 m (59 ft.) south of State Highway 203, and 1 m (3 ft.) south of a witness post (See figure 9). Bench mark is stamped "37 EGE 1983". Note: New mortar was poured around the bench mark.
- 36 EGE 3.61 km (2.25 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on bedrock on the outside of a curve, 12 m (38 ft.) south of the centerline of State Highway 203, 2.4 m (8 ft.) southeast of the northwest end of a 4 m (12 ft.) high basalt outcrop, and 1.3 m (4 ft.) southwest of a witness post (See figure 10). Standard USGS Bench mark is stamped "36 EGE 1983".

- 35 EGE 3.88 km (2.4 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on a 1.2 m (4 ft.) high rock bench on the northeast corner of a 3 m (9 ft.) high lava outcrop, 10 m (33 ft.) south of the centerline of State Highway 203, and 2.5 m (8 ft.) south of a witness post (See figure 11). Bench mark is stamped "35 EGE 1983".
- 2 LRM 4.09 km (2.55 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on a small exposure of bedrock, 34 m (111 ft.) south of the centerline of State Highway 203, at a pull out, approximately 4 m (13 ft.) above road level, and 1 m (3 ft.) southeast of a witness post (See figure 12). Bench mark is stamped "2 LRM 1985".
- 1 LRM 4.93 km (3.05 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on the south end of a 1.5 X 1.5 (5 X 5 ft.) exposure of bedrock, projecting 1 m (3 ft.) above the ground level, 34 m (111 ft.) south of the centerline of State Highway 203, 1.4 m (5 ft.) north of highway right-of-way fence, approximately 4.5 m (15 ft.) lower than the road level, and 1.4 m (5 ft.) north of a witness post (See figure 13). Bench mark is stamped "1 LRM 1985". Note: New mortar was poured around the bench mark.
- 34 EGE 4.96 km (3.1 mi.) east along the east-bound lanes of State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on the north end of a 1.2 X 2 m (4 X 6 ft.) embedded granite boulder projecting 1 m (3 ft.) above the ground level, 30 m (98 ft.) north of State Highway 203, and 1.4 m (4.5 ft.) south of a witness post (See figure 14). Bench mark is stamped "34 EGE 1983". Note: New mortar was poured around the bench mark.
- DBR 21 5.58 km (3.45 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes. Bench mark is cemented on the concrete base of a highway lamp post on the southeast corner of the intersection formed by the exit ramp from U. S. Highway 395 and old Mammoth road, 11.5 m (38 ft.) south of old Mammoth road, 13 m (44 ft.) east of the "off ramp" from U. S. Highway 395, and 0.9 m (3 ft.) above road level (See figure 15). Bench mark is stamped " DBR 21 1983".
- DBR 20 5.65 km (3.5 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, and 0.17 km (0.1 mi.) east of U.S. Highway 395 crossing. Bench mark is at the south end of a cattle guard, attached to a metal rod driven between the slates of the cattle guard and 6 m (20 ft.) south of the centerline of old Mammoth road (See figure 16). Bench mark

is stamped "DBR 20 1983".

- DBR 19 5.67 km (3.5 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, and 0.22 km (0.15 mi.) east of U.S. Highway 395 crossing. Bench mark is attached to a metal rod enclosed in a 20 cm (8 in.) diameter PVC plastic pipe projecting 0.5 m (20 in.) above ground level, 7.2 m (23 ft.) south of the centerline of old Mammoth road, and 1 m (3 ft.) south of a metal fence post (See figure 17). Bench mark is stamped "DBR 19 1983".
- DBR 18 5.75 km (3.6 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, and 0.35 km (0.2 mi.) east of U.S. Highway 395 crossing. Bench mark is attached to a metal rod enclosed in a 20 cm (8 in.) diameter PVC plastic pipe projecting 30 cm (12 in.) above ground level, 8 m (26 ft.) south of the centerline of old Mammoth road, and 1 m (3 ft.) south of a metal fence post (See figure 18). Bench mark is stamped "DBR 18 1983".
- DBR 15 5.91 km (3.65 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, and 0.46 km (0.3 mi.) east of U.S. Highway 395 crossing. Bench mark is attached to a metal rod enclosed in a 20 cm (8 in.) diameter PVC plastic pipe projecting 0.3 m (12 in.), 4.6 m (15 ft.) north of the centerline of old Mammoth road, and 0.5 m (1.6 ft.) south of a witness post (See figure 19). Bench mark is stamped "DBR 15 1983".
- DBR 13 6.03 km (3.75 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, and 0.58 km (0.35 mi.) east of U.S. Highway 395 crossing. Bench mark is attached to a metal rod projecting (PVC pipe is missing) 0.15 m (6 in.) above ground level, 6 m (20 ft.) north of the centerline of old mammoth road, 37 m (121 ft.) east of power line crossing, and 0.9 m (3 ft.) west of a metal fence post (See figure 20). Bench mark is stamped "DBR 13 1983".
- DBR 12 6.11 km (3.8 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, and 0.66 km (0.4 mi.) east of U.S. Highway 395 crossing. Bench mark is attached to a metal rod projecting 0.15 m (6 in.), 8.2 m (27 ft.) north of the centerline of old mammoth road, and 0.8 m (2.6 ft.) west of a metal fence post (See figure 21). Bench mark is stamped "DBR 12 1983".
- DBR 11 6.15 km (3.8 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, 0.69 km (0.45 mi.) east of U.S. Highway 395 crossing and at the "T" junction of old U.S. Highway 395. Bench mark is attached to a metal rod enclosed in a 20 cm (8 in.) diameter (broken) PVC

plastic pipe projecting 0.35 m (14 in.) above ground level, 4.8 m (16 ft.) north of the center of the "T" junction, and 1 m (3 ft.) west of a wooden sign post (See figure 22). Bench mark is stamped "DBR 11 1983".

- CASA 6.16 km (3.8 mi.) east along State Highway 203 from the entrance to the post office at Mammoth Lakes, 0.69 km (0.45 mi.) east of U.S. Highway 395 crossing, at the "T" junction with old U.S. Highway 395. Bench mark is cemented in the top of a concrete post, at ground level, 34 m (112 ft.) northeast of the centerline of old U.S. Highway 395, 2 m (6.5 ft.) north of a double power pole, and 1 m (3 ft.) east of a witness post (See figure 23). Bench mark is a Coast and Geodetic Survey azimuth tablet stamped "CASA 1956".
- J 1383 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads. Mark is a stainless-steel rod enclosed in a 12.7 cm (5 in.) PVC pipe with a metal cap, in the northeast quadrant of the road intersection, 25 m (82 ft.) north from the double centerline of State Highway 203, 18 m (59 ft.) east of the centerline of the road to Minaret Summit, and 1 m (3 ft.) east of a witness post (See figure 24). Stamping on metal ring holding cap is "J 1383 1986".
- H 1383 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 0.86 km (0.55 mi.). Bench mark is cemented on the east end of a 1 X 1.2 m (3 X 4 ft.) rock outcrop, projecting 0.3 m (1 ft.) above ground level, 20 m (65 ft.) south of the centerline of the road, approximately 1.8 m (6 ft.) lower than the road level, and 0.6 m (2 ft.) east of a witness post (See figure 25). Bench mark is stamped "H 1383 1986".
- 5 JCM 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 1.40 km (0.9 mi.). Bench mark is on the outside of a curve, cemented on a 2 X 2 m (6 X 6 ft.) embedded boulder projecting 0.6 m (2 ft.) above ground level, 15 m (50 ft.) northeast of the centerline of road, and 0.7 m (2.3 ft.) west of a witness post (See figure 26). Bench mark is stamped "5 JCM 1982".
- G 1383 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 1.96 km (1.2 mi.). Mark is a stainless-steel rod

enclosed in 12.7 cm (5 in.) diameter PVC pipe with a metal cap, 16 m (52 ft.) northwest of the centerline of the highway, 40 m (130 ft.) southwest of a curve sign, approximately 3.7 m (ft.) above road level, and 1 m (3 ft.) south of a witness post (See figure 27). Stamping on metal ring holding cap is "G 1383 1986".

- F 1383 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 2.71 km (1.7 mi.). Bench mark is cemented in bedrock 0.13 km (0.1 mi.) east of a road leading north to "Earthquake Fault", 27 m (90 ft.) southwest of highway centerline, 0.5 m (1.7 ft.) northeast of a 7 m (20 ft.) deep earth crack, and approximately 4 m (13 ft.) lower than the road level (See figure 28). Bench mark is stamped "F 1383 1986".
- 6 JCM 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 2.89 km (1.8 mi.). Bench mark is cemented on the top of a 1.5 X 1.8 m (5 X 6 ft.) boulder projecting 1.2 m (4 ft.) above the ground level, 29 m (94 ft.) northeast of the centerline of the highway, 13 m (42 ft.) northeast of the center of the road leading to "Earthquake Fault", and 1.5 m (5 ft.) southwest of a witness post (See figure 29). Bench mark is stamped "6 JCM 1982".
- E 1383 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 3.56 km (2.2 mi.). Mark is a stainless-steel rod enclosed in a 12.7 cm (5 in.) PVC pipe with a metal cap, 13 m (42 ft.) south of the centerline of the highway, 27 m (89 ft.) west of the center of the road leading to the ski lift maintenance area, approximately 1 m (3 ft.) above road level, and 1 m (3 ft.) west of a witness post (See figure 30). Stamping on the metal ring holding cap is "E 1383 1986".
- 7 JCM 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 4.00 km (2.5 mi.) to a road leading to the left. Leave the paved road and turn into the dirt road to the south and continue 0.11 km (0.05 mi) to a junction with another dirt road. Bench mark is cemented on the concrete foundation of chair 20, ski lift support, 0.29 km (0.2 mi.) west of power pole crossing, and 0.3 m (1 ft.) northeast of the main vertical support for the chair lift. Bench mark is stamped "7 JCM 1982". No

photograph taken of this bench mark.

- 8 JCM 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 5.20 km (3.2 mi.). Bench mark is cemented on the west end of a 1.8 X 3 m (6 X 10 ft.) embedded boulder projecting 1.2 m (4 ft.) above ground level, 23.8 m (78 ft.) south of the centerline of highway, and 2 m (6 ft.) east of a witness post (See figure 31). Bench mark is stamped "8 JCM 1982".
- JEE 1 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 5.65 km (3.5 mi.). Bench mark is attached to a metal rod enclosed in a 15 cm (6 in.) PVC pipe at the southern end of a parking lot with a sign "No overnight parking, No RV parking", 1.5 m (5 ft.) north of the sign post, and 7 m (23 ft.) west of the edge of the road pavement (See figure 32). Bench mark is stamped "JEE 1".
- JEE 3 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 5.79 km (3.6 mi.). Bench mark is attached to a metal rod enclosed in a 15 cm (6 in.) PVC pipe at the northern end of the same parking lot as JEE 1, near a "No overnight parking" sign, 2.1 m (7 ft.) southwest of a "ICY" sign, and 3.5 m (11.5 ft) from the west edge of road pavement (See figure 33). Bench mark is stamped "JEE 3".
- JEE 6 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 5.96 km (3.7 mi.). Bench mark is attached to the top of a metal rod enclosed in a 15 cm (6 in.) PVC pipe, west of sign "Shuttle D", and 4.8 m (16 ft.) north of the edge of road pavement (See figure 34). Bench mark is stamped "JEE 6".
- JEE 9 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 6.04 km (3.75 mi.). Bench mark is attached to a metal rod enclosed in a 15 cm (6 in.) PVC pipe, and east of a sign "Shuttle C" (See figure 35). Bench mark is stamped "JEE 9".

- JEE 12 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 6.16 km (3.82 mi.). Bench mark is attached to a metal rod enclosed in a 15 cm (6 in.) PVC pipe on the north side of the road, and west of a sign "Shuttle "C" (see figure 36). Note: This bench mark was not surveyed during the 1989 survey.
- JEE 15 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 6.28 km (3.9 mi.). Bench mark is attached to the top of a metal rod enclosed in a 15 cm (6 in.) PVC pipe, 4.0 m (14 ft.) north of the edge of the road pavement (See figure 37). Bench mark is stamped "JEE 15".
- JEE 17 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 6.40 km (4.0 mi.). Bench mark is attached to the top of a metal rod enclosed in a 15 cm (6 in.) PCV pipe, 1.9 m (6 ft.) east of a 1 m (3 ft.) diameter pine tree, 70 m (229 ft.) south of a sign "Thank you for visiting MAMMOTH", and 3 m (10 ft.) north of the edge of the road pavement (See figure 38). Bench mark is stamped " JEE 17".
- JEE 19 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 6.47 km (4.04 mi.). Bench mark is attached to the top of a metal rod enclosed in a 15 cm (6 in.) PVC pipe, beneath and slightly west of a sign "Thank you for visiting MAMMOTH", and 4.7 m (15.5 ft.) north of the edge of the road pavement (See figure 39). Bench mark is stamped "JEE 19".
- JEE 20 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 6.55 km (4.05 mi.). Bench mark is attached to the top of a metal rod enclosed in a 15 cm (6 in.) PVC pipe (no photograph was taken of this bench mark). Bench mark is stamped "JEE 20".
- JEE 22 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to

Minaret Summit for 6.72 km (4.15 mi.). Bench mark is attached to the top of a metal rod enclosed in a 15 cm (6 in.) PVC pipe, 1 m (3 ft.) north of the edge of the pavement, and 1.2 m (4 ft.) south of a triad of 1 m (3 ft.) diameter pine trees at the south end of the parking lot at the ski resort (See figure 40). Bench mark is stamped "JEE 22".

- 9 JCM 1.5 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 6.98 km (4.35 mi.) to the parking area at Mammoth ski resort, then north for 0.14 km (0.1 mi) along a circular driveway to the main entrance to Mammoth Inn. Bench mark is cemented on a concrete retaining wall, 3.6 m (12 ft.) south of a side entrance (See figure 41). Bench mark is stamped "9 JCM 1982".
- 42 EGE 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 8.25 km (5.1 mi.). Bench mark is cemented on the south ledge of a large embedded boulder 53 m (173 ft.) north of the centerline of the highway, 59 m (193 ft.) north of a witness post on the south side of the highway, and 1 m (3 ft.) north of a witness post. Bench mark is stamped "42 EGE 1983". No photograph taken of this bench mark.
- 20 JD 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 9.03 km (5.5 mi.) to a junction on the north leading to "Minaret Vista" viewpoint. Bench mark is cemented in a concrete post projecting 10 cm (4 in.) above ground level, 13 m (43 ft.) north of the center of highway, 7.3 m (24 ft.) north of the center of road to "Minaret Vista" viewpoint, and 12 m (39 ft.) northeast of the northeast corner of a Forest Service check point (See figure 42). Bench mark is stamped "20 JD 1952 9175".
- D 1383 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 9.04 km (5.5 mi.) to a road junction on the north leading to "Minaret Vista" viewpoint. Mark is a stainless-steel rod enclosed in a 12.7 cm (5 in.) PVC pipe with a metal cap, 17 m (65 ft.) north of the centerline of the highway, 8 m (26.5 ft.) east of the center of the road leading to "Minaret Vista" viewpoint, 15 m (50.5 ft.) east of BM 20 JD, and 0.6 m (2 ft.) north of a witness post (See figure 43). Stamping on metal ring

holding cap is "D 1383 1986".

- RET 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersection of Lake Mary, State Highway 203, and Minaret Summit roads, then north along the road to Minaret Summit for 9.04 km (5.5 mi.) to a road junction to the east. Leave the main paved road and turn right onto the side road, continue along the road for 0.58 km (0.2 mi.) to "Minaret Vista" viewpoint. Bench mark is cemented in a small exposure of bedrock on the west side of the road on the side of a small hill, approximately 30 m (98 ft.) west of the road way, and approximately 4.5 m (15 ft.) above road level. Bench mark is stamped "RET". No photograph taken of this bench mark.
- CVO89-311 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 0.94 km (0.6 mi.). Bench mark is cemented on the northwest corner of a 1.5 X 3 m (5 X 10 ft.) concrete slab enclosed within a 1.8 X 6 m (6 X 29 ft.) tile retaining wall, next to a 1 m (3 ft.) diameter manhole cover, 7.5 m (24 ft.) northwest of the centerline of the highway, and approximately 15 m (50 ft.) northeast of Kelly road intersection. Approximately 2.4 m (8 ft.) above the bench mark is a green 1.5 X 1.5 X 1 m (5 X 5 X 3 ft.) electrical box (See figure 44). Bench mark is stamped "CVO89-311".
- VISTA 89 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 2.25 km (1.4 mi.). Bench mark is cemented on the southwest end of a concrete headwall of a drainage culvert, 4.7 m (15.4 ft.) west of the centerline of the highway, and 9.3 m (30.5 ft.) north-northwest of a 1 m (3 ft.) diameter pine tree with a 2.5 X 4.9 X 61 cm (1 X 2 X 24 in.) wooden stake attached, 1.8 m (6 ft.) above ground level (See figure 44a). Bench mark is stamped "VISTA 89".
- CVO89-310 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 2.62 km (1.6 mi.). Bench mark is cemented on the northeast end of a concrete headwall of a culvert, 5.9 m (19 ft.) northwest of the centerline of the highway, 9.6 m (31.5 ft.) east-southeast of a 1.5 m (5 ft.) diameter pine tree with a 2.5 X 4.9 X 61 cm (1 X 2 X 24 in.) wooden stake attached 1.8 m (6 ft.) above ground level, and 0.08 km (0.05 mi.) east of a green metal pipe gate (See figure 45). Bench mark is stamped "CVO89-

310".

- CVO89-309 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 3.60 km (2.25 mi.). Bench mark is cemented on a concrete retaining wall of a spillway under a bridge, 4.8 m (16 ft.) east of the centerline of the highway, 1 m (3 ft.) east, of the east end of a metal guard rail, and 0.7 m (2.5 ft.) lower than the road level (See figure 45a). Bench mark is stamped "CVO89-309".
- CVO89-308 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 4.72 km (2.93 mi.). Bench mark is cemented on a 1.2 X 1.2 m (4 X 4 ft.) embedded boulder projecting 0.7 m (2.5 ft.) above ground level, 1.5 m (5 ft.) above the track road to a water tank, 14.6 m (48 ft.) east of the centerline of the main highway, 10.9 m (36 ft.) north-northwest of the center of Forest Service road 19, and 4.6 m (15 ft.) south of the east corner post of a metal gate (See figure 46). Bench mark is stamped "CVO89-308". NOTE: A GPS bench mark (bench mark is on a "floating boulder" and is most likely very unstable) is located 5.6 m (18 ft.) southwest of this bench mark.
- CVO89-307 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 5.14 km (3.19 mi.). Bench mark is cemented on top of a 1.2 X 2.4 m (4 X 8 ft.) embedded boulder, projecting 0.45 m (1.2 ft.) above ground level, 0.30 m (1 ft.) above the road level, 9 m (29.5 ft.) northeast of the centerline of the highway, 1.5 m (5 ft.) southwest of a 0.6 m (2 ft.) diameter pine tree, with a 0.2 X 2.1 m (8 in. X 7 ft.) long gash on the north side of the trunk, and 4 m (13 ft.) southwest of a 0.45 m (1.5 ft.) diameter pine tree with a 2.4 X 4.9 X 61 cm (1 X 2 X 24 in.) stake attached 1.8 m (6 ft.) above ground level (See figure 46a). Bench mark is stamped "CVO89-307".
- CVO89-306 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 5.38 km (3.34 mi.). Bench mark is cemented on top of a 0.9 X 1.2 m (3 X 4 ft.) embedded boulder projecting 0.20 m (8 in.) above ground level, 0.46 m (1.5 ft.) above road level and 1.2 m (4 ft.) west of a 0.9 X 1.2 m (3 X 4 ft.) boulder projecting 0.9 m (3 ft.) above ground level.

Bench mark is 7.1 m (23 ft.) northeast of the centerline of the highway, 9.3 m (30 ft.) south-southwest of the southwest corner of a metal gate post, 24.1 m (79 ft.) southeast of a horse crossing sign, and nearly opposite a "Mammoth Lakes Pack Outfit" sign. Bench mark is stamped "CVO89-306". No photograph taken of this bench mark.

- CVO89-305 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 5.64 km (3.5 mi.). Bench mark is cemented on the northwest corner of a 1.5 X 1.5 m (5 X 5 ft.) concrete vault with a 0.9 m (3 ft.) diameter steel cover, 5 m (16 ft.) northeast of the centerline of the highway, 4 m (13 ft.) north-northwest of a horse crossing sign, and directly across a closed off road leading to a large green water tank (See figure 47). Bench mark is stamped "CVO89-305".
- CVO89-304 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 6.02 km (3.73 mi.). Bench mark is cemented on the east end of a 1.8 X 2.4 (6 X 8 ft.) concrete cistern, 0.3 m (1 ft.) above ground level, and about 1.2 m (4 ft.) above road level, 21 m (69 ft.) south of the centerline of the highway, at the end of a short track road leading towards the lake, and approximately 25 m (82 ft.) southwest of a "T" intersection sign (See figure 47a). Bench mark is stamped "CVO89-304".
- CVO89-303 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 6.41 km (3.97 mi.). Bench mark is cemented on a 0.9 X 2.1 m (3 X 7 ft.) embedded boulder, projecting 0.15 m (0.5 ft) above ground level, 27 m (88.5 ft.) north-northeast of the centerline of the highway, 24.8 m (81.3 ft.) northeast of a 0.9 X 1.56 m (3 X 5 ft.) milage information sign, across the street from the "POKONOBE MARINA" sign, and 6 m (19.6 ft.) southwest of a 0.46 m (1.5 ft.) diameter pine tree with a 2.4 X 4.9 X 61 cm (1 X 2 X 24 in.) wooden stake attached 1.8 m (6 ft.) above ground level (See figure 48). Bench mark is stamped "CVO89-303".
- CVO89-302 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 6.94 km (4.3 mi.). Bench mark is cemented on the top of 0.9 X 1.5 m (3 X 5 ft.) embedded boulder, 25.6 m (84 ft.) west of the centerline of the highway, 28.3 m (93 ft.) south of the east corner of the porch of a

cabin, 10.2 m (33.5 ft.) northwest of a 0.45 m (1.5 ft.) diameter pine tree with 0.2 X 0.2 m (18 X 18 in.) blue trail marker approximately 3.6 m (12 ft.) above the ground level, and 5.5 m (18 ft.) southeast of the center of a track road . The track road is directly opposite an "Equestrian Xing" sign, and a 2.4 X 3 m (8 x 10 ft.) boulder (See figure 48a). Bench mark is stamped "CVO89-302".

CVO89-301 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 7.47 km (4.63 mi.). Bench mark is cemented on a large exposure of bedrock, 23.7 m (78 ft.) southwest of the center of the highway, opposite a wooden guard rail, approximately 0.6 m (2 ft.) lower than the roadbed, and 5.4 m (18 ft.) north-northwest of a 0.76 m (2.5 ft.) diameter pine tree. The pine tree has a 0.20 X 1.1 m (8 X 36 in.) long gash on the trunk and a 2.4 X 4.9 X 61 cm (1 X 2 X 24 in.) wooden stake attached 1.8 m (6 ft.) above the ground level (See figure 49). Bench mark is stamped "CVO89-301".

CVO89-300 1.05 km (0.65 mi.) west along State Highway 203 from the entrance to the post office at Mammoth Lakes to the intersections of Lake Mary, State Highway 203, and Minaret Summit roads, then southwest along the road to Lake Mary for 8.29 km (5.14 mi.). Bench mark is cemented on a 1.5 X 1.5 m (5 X 5 ft.) embedded boulder, projecting 0.45 m (1.5 ft.) above the ground level, 11.6 m (38 ft.) west-southwest of the west-southwest corner of a rest room building, and 13.65 m (44.8 ft.) southeast of "Mammoth Pass Trail" sign (See figure 49a). Bench mark is stamped " CVO89-300.

TABLE 1

Bench mark ID	Elev Diff (m) between bm's	Elevation (m)	Stadia Dist km	Stadia Dist miles
RET®		2823.57461		
D 1383	-27.25053	2796.32408	0.36	0.25
20 JD	0.11702	2796.44110	0.02	0.00
42 EGE	-37.15622	2759.28488	0.78	0.50
9 JCM	-44.23408	2715.05080	1.27	0.81
JEE 22	-9.73419	2705.31661	0.25	0.19
JEE 20	-8.74452	2696.57209	0.17	0.12
JEE 19	-4.11311	2692.45898	0.09	0.06
JEE 17	-3.85967	2688.59931	0.07	0.06
JEE 15	-5.67699	2682.92232	0.12	0.06
JEE 9	-6.74929	2676.17303	0.24	0.12
JEE 6	0.09110	2676.26413	0.08	0.06
JEE 3	-5.64158	2670.62255	0.17	0.12
JEE 1	1.80886	2672.43141	0.15	0.06
8 JCM	18.00993	2690.44134	0.04	0.25
SHUTTLE4*	-34.80100	2655.64034	0.99	0.62
7 JCM	-0.75012	2654.89022	0.09	0.06
E 1383	-22.82974	2632.06048	0.56	0.37
6 JCM	-35.94132	2596.11916	0.67	0.43
F 1383	-13.27972	2582.83944	0.18	0.12
G 1383	-37.46201	2545.37743	0.75	0.43
5 JCM	-40.44688	2504.93055	0.57	0.37
H 1383	-31.25706	2473.67349	0.53	0.31
J 1383	-29.40292	2444.27057	0.86	0.56
K 1383	-49.31642	2394.95415	1.05	0.68
3 JCM	-22.05705	2372.89710	1.09	0.68
STA 907	-15.57938	2357.31772	0.51	0.31
3 LRM	0.15997	2357.47769	0.08	0.06
40 EGE	-13.41224	2344.06545	0.46	0.31
39 EGE	-11.94709	2332.11836	0.34	0.19
2 JCM	-0.32006	2331.79830	0.32	0.19
38 EGE	-5.47581	2326.32249	0.25	0.12
37 EGE	-9.60284	2316.71965	0.22	0.12
36 EGE	-15.92353	2300.79612	0.34	0.19
35 EGE	-12.59648	2288.19964	0.30	0.19
2 LRM	-4.68519	2283.51445	0.21	0.12
1 LRM	-44.45282	2239.06163	0.84	0.50
34 EGE	3.58969	2242.65132	0.08	0.06
DBR 21	-12.45778	2230.19354	0.62	0.37

DBR 20	-1.06108	2229.13246	0.04	0.00
DBR 19	-1.73364	2227.39882	0.05	0.06
DBR 18	-3.37992	2224.01890	0.08	0.06
DBR 15	-8.81796	2215.20094	0.16	0.12
DBR 13	-4.78111	2210.41983	0.11	0.06
DBR 12	-0.15183	2210.26800	0.08	0.06
DBR 11	-0.07200	2210.19600	0.04	0.00
CASA	-0.36057	2209.83543	0.06	0.06

@ This bench mark was held "fixed" to the 1986 NGS elevation and all elevations are relative to this bench mark.

\* This is a temporary bench mark (TBM) and therefore is not described in the appendix.

TABLE 1 (continuation)

Bench mark ID	Elev Diff (m) between bm's	Elevation (m)	Dist km	Dist miles
J 1383		2444.27057		
CVO89-311	44.63664	2488.90721	0.94	0.56
VISTA89	65.27653	2554.18471	1.31	0.81
CVO89-310	18.11375	2572.29846	0.36	0.25
CVO89-309	44.25508	2616.55354	0.99	0.62
CVO89-308	50.96604	2667.51958	0.42	0.68
LAKE MARY*	0.10082	2667.62040	0.03	0.00
CVO89-307	22.59591	2690.21631	0.42	0.25
CVO89-306	10.50510	2700.72141	0.24	0.12
CVO89-305	4.84219	2705.56360	0.26	0.19
CVO89-304	12.69694	2718.26054	0.37	0.25
CVO89-303	4.29280	2722.55334	0.41	0.25
CVO89-302	8.63422	2731.18756	0.40	0.25
CVO89-301	8.04749	2739.23505	0.40	0.31
CVO89-300	15.47094	2754.70599	0.82	0.50

\* This is a temporary bench mark (TBM) and therefore is not described in the appendix.

## References

- Federal Geodetic Control Committee, 1984, Standards and Specifications for Geodetic Control networks: Rockville, Maryland, National Oceanic and Atmospheric Administration.
- Yamashita, K.M., 1989, Using the "HP-71B" hand-held computer for data entry while running first order class II level surveys: U.S. Geological Survey Open-File Report 89-179, 21 p.
- Yamashita, K.M., and Kaiser, W.P., 1990 Using First-Order Class II Geodetic Leveling, in Ewert J.W., and Swanson, D.A., eds., 1990, Monitoring Volcanoes: Techniques and Strategies Used by the Staff of the Cascades Volcano Observatory, 1980-1990: Chapter 13, 7p.

Figure 1



K 1383

View looking north-northeast  
Arrow at tripod points to bench mark



K 1383

View looking northwest  
Arrow at tripod points to bench mark

**Figure 2**



**3 JCM**                      View looking northwest  
Arrow at tripod points to bench mark



**3 JCM**                      View looking north  
Arrow at tripod points to bench mark



Figure 3

STA 907

View looking southeast  
Arrow at tripod points to bench mark



STA 907

View looking southwest  
Arrow at tripod points to bench mark



Figure 4

3 LRM

View looking south  
Arrow at tripod points to bench mark



3 LRM

View looking southeast  
Arrow at tripod points to bench mark

**Figure 5**



**40 EGE**

View looking north  
Arrow at tripod points to bench mark



**40 EGE**

View looking north-northwest  
Arrow at tripod points to bench mark

Figure 6



39 EGE

View looking southwest  
Arrow at tripod points to bench mark



39 EGE

View looking south  
Arrow at tripod points to bench mark

Figure 7



2 JCM

View looking west-southwest  
Arrow at tripod points to bench mark



2 JCM

View looking south  
Arrow at tripod points to bench mark

Figure 8



38 EGE

View looking south  
Arrow at tripod points to bench mark



38 EGE

View looking southwest  
Arrow at tripod points to bench mark



37 EGE

View looking south  
Arrow at tripod points to bench mark



37 EGE

View looking southwest  
Arrow at tripod points to bench mark



36 EGE

View looking southwest  
Arrow at tripod points to bench mark



36 EGE

View looking south  
Arrow at tripod points to bench mark



35 EGE

View looking east-southeast  
Arrow at tripod points to bench mark



35 EGE

View looking south  
Arrow at tripod points to bench mark

Figure 12



2 LRM

View looking south-southeast  
Arrow at tripod points to bench mark



2 LRM

View looking south  
Arrow at tripod points to bench mark

Figure 13



34 EGE

View looking northwest  
Arrow at tripod points to bench mark



34 EGE

View looking north  
Arrow at tripod points to bench mark



1 LRM

View looking southeast  
Arrow at tripod points to bench mark



1 LRM

View looking south  
Arrow at tripod points to bench mark



Figure 15

DBR 21

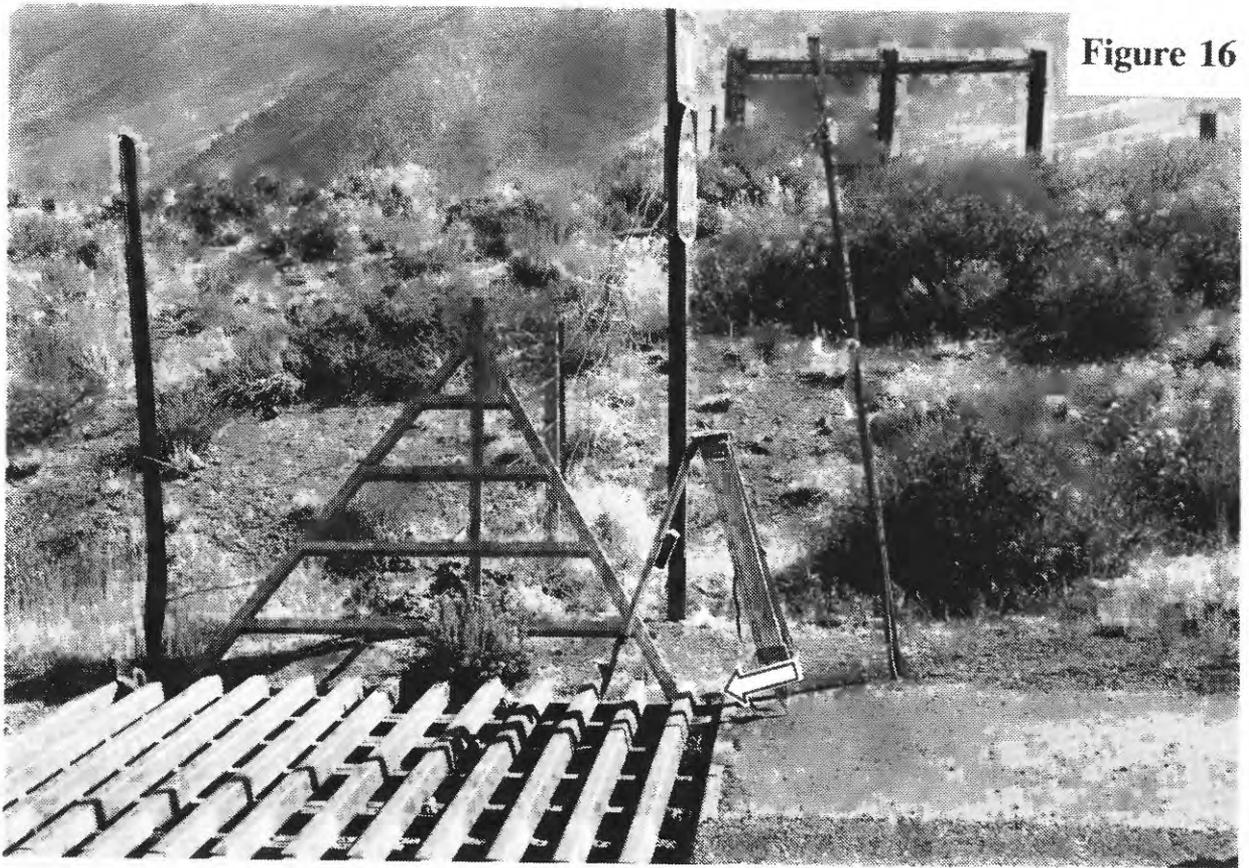
View looking east  
Arrow at tripod points to bench mark



DBR 21

View looking southwest  
Arrow at tripod points to bench mark

Figure 16



DBR 20

View looking southeast  
Arrow at tripod points to bench mark



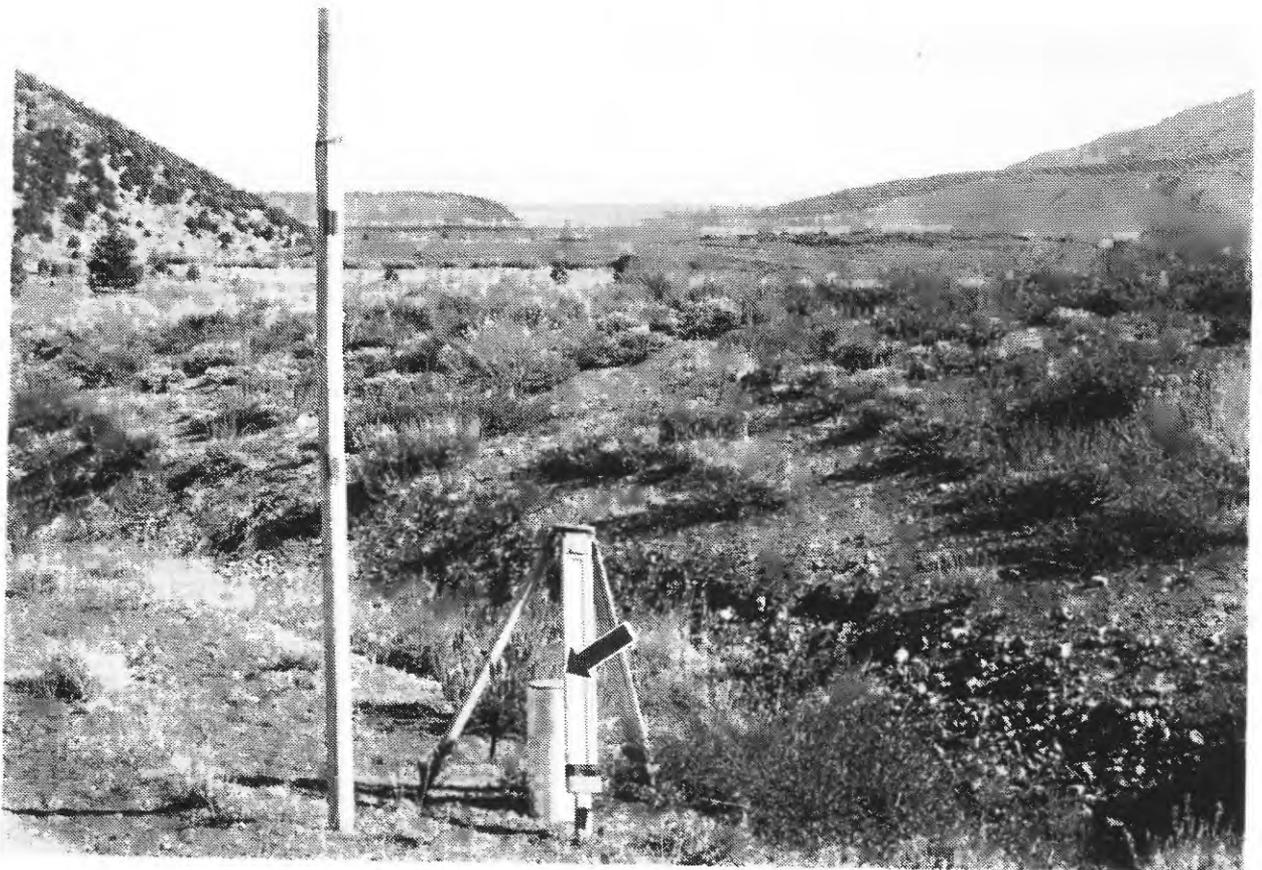
DBR 20

View looking northeast  
Arrow at tripod points to bench mark



DBR 19

View looking southwest  
Arrow at tripod points to bench mark



DBR 19

View looking southeast  
Arrow at tripod points to bench mark

Figure 18



DBR 18

View looking south west  
Arrow at tripod points to bench mark



DBR 18

View looking west  
Arrow at tripod points to bench mark

Figure 19



DBR 15

View looking east  
Arrow at tripod points to bench mark



DBR 15

View looking north  
Arrow at tripod points to bench mark



DBR 13

View looking west  
Arrow at tripod points to bench mark



DBR 13

View looking north  
Arrow at tripod points to bench mark

**Figure 21**



DBR 12

View looking west  
Arrow at tripod points to bench mark



DBR 12

View looking north  
Arrow at tripod points to bench mark

Figure 22



DBR 11

View looking east-northeast  
Arrow at tripod points to bench mark



DBR 11

View looking north  
Arrow at tripod points to bench mark



CASA AZI

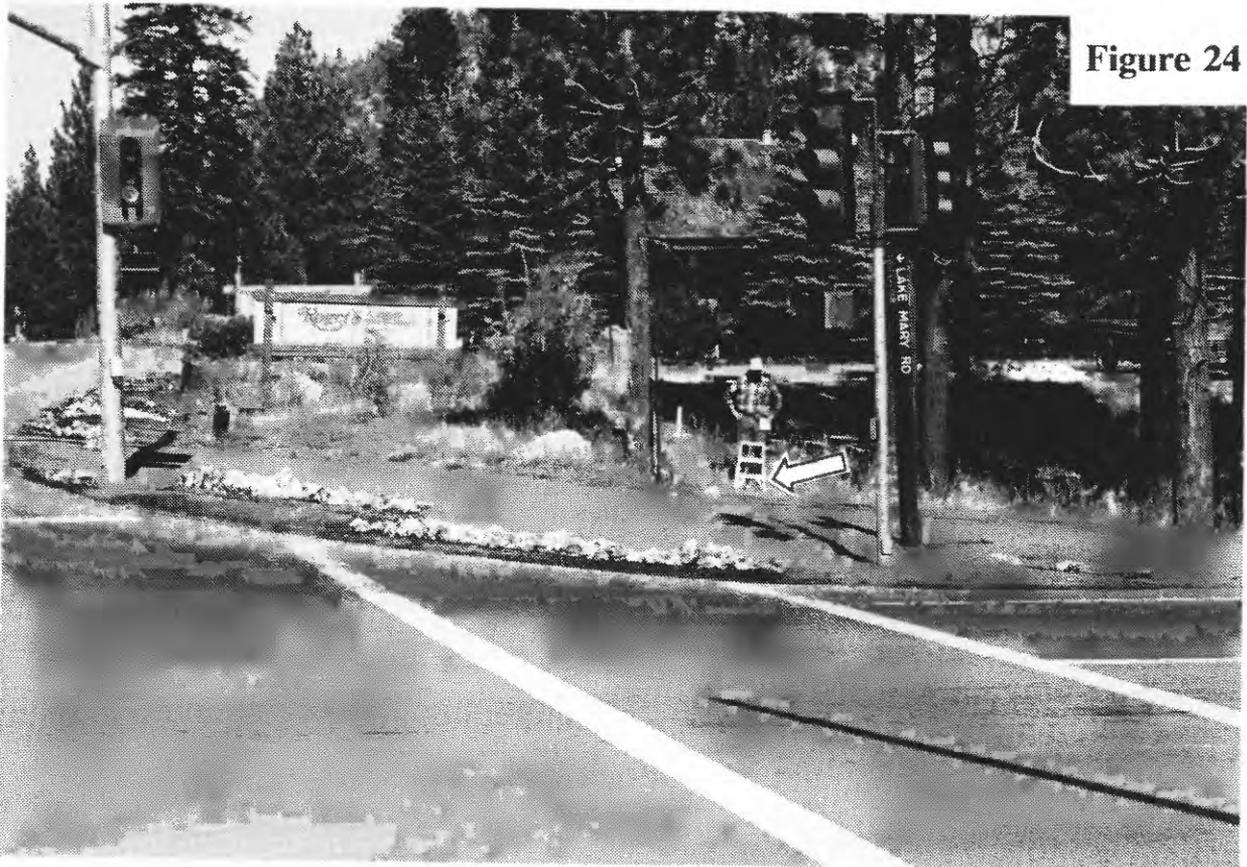
View looking north  
Arrow points to bench mark



CASA AZI

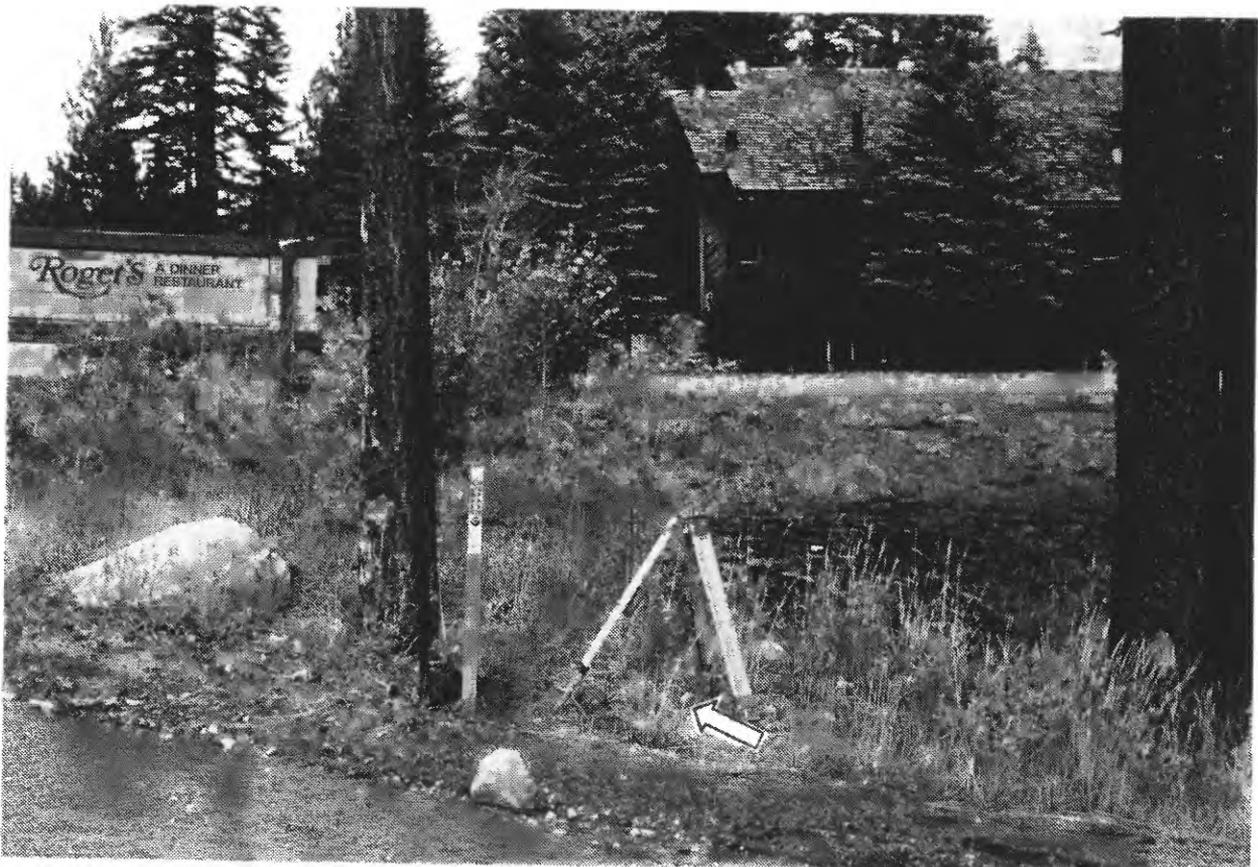
View looking north  
Arrow points to bench mark

Figure 24



J 1383

View looking northwest  
Arrow at step ladder points to bench mark



J 1383

View looking west  
Arrow at tripod points to bench mark



Figure 25

H 1383

View looking south  
Arrow points to bench mark



H 1383

View looking southwest  
Arrow points to bench mark

Figure 26



5 JCM

View looking east  
Arrow at tripod points to bench mark



5 JCM

View looking northwest  
Arrow at tripod points to bench mark

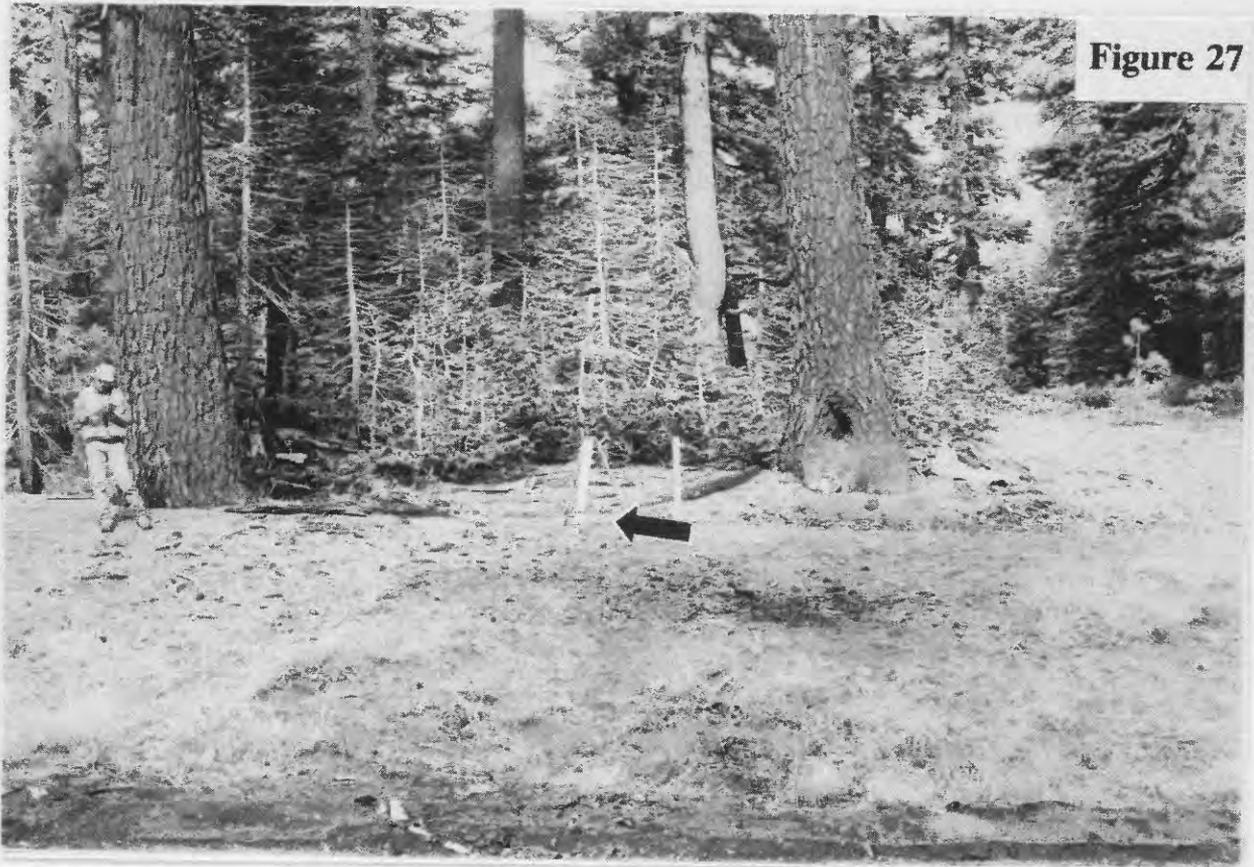


Figure 27

G 1383

View looking northwest  
Arrow at tripod points to bench mark



G 1383

View looking northwest  
Arrow at tripod points to bench mark



F 1383

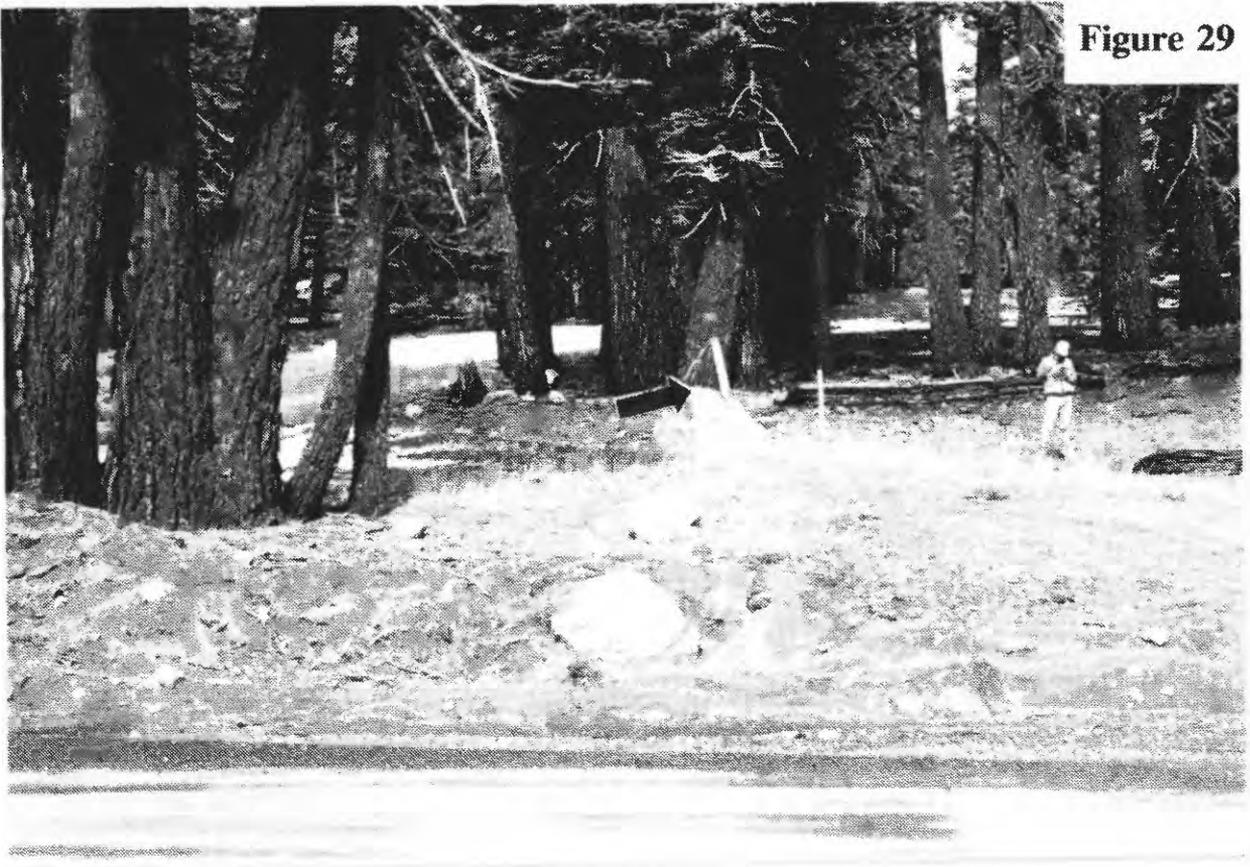
View looking southwest  
Arrow at tripod points to bench mark



F 1383

View looking southeast  
Arrow at tripod points to bench mark

Figure 29



6 JCM

View looking north  
Arrow at tripod points to bench mark



6 JCM

View looking northwest  
Arrow at tripod points to bench mark



E 1383

View looking east  
Arrow at tripod points to bench mark



E 1383

View looking west  
Arrow at tripod points to bench mark



Figure 31

8 JCM

View looking south  
Arrow at tripod points to bench mark



8 JCM

View looking south  
Arrow at tripod points to bench mark



JEE 1

View looking southwest  
Arrow at tripod points to bench mark



JEE 1

View looking west  
Arrow at tripod points to bench mark

Figure 33



JEE 3

View looking south  
Arrow at tripod points to bench mark



JEE 3

View looking southeast  
Arrow at tripod points to bench mark

Figure 34



JEE 6

View looking northeast  
Arrow at tripod points to bench mark



JEE 6

View looking east-southeast  
Arrow at tripod points to bench mark



**JEE 9**

View looking west  
Arrow at tripod points to bench mark



**JEE 9**

View looking north  
Arrow at tripod points to bench mark

Figure 36



JEE 12

View looking north  
Arrow at tripod points to bench mark



JEE 12

View looking east  
Arrow at tripod points to bench mark



JEE 15

View looking west  
Arrow at tripod points to bench mark



JEE 15

View looking north  
Arrow at tripod points to bench mark



JEE 17

View looking north  
Arrow at tripod points to bench mark



JEE 17

View looking west  
Arrow at tripod points to bench mark



JEE 19

View looking northeast  
Arrow at tripod points to bench mark



JEE 19

View looking northeast  
Arrow at tripod points to bench mark



JEE 22

View looking west-northwest  
Arrow points to bench mark



JEE 22

View looking north  
Arrow points to bench mark

Figure 41



9 JCM

View looking northwest  
Arrow at tripod points to bench mark



9 JCM

View looking north  
Arrow at tripod points to bench mark

Figure 42



20 JD

View looking west  
Arrow at tripod points to bench mark



20 JD

View looking southwest  
Arrow at tripod points to bench mark



D 1383

View looking north  
Arrow at tripod points to bench mark



D 1383

View looking east-northeast  
Arrow at tripod points to bench mark



Figure 44

CVO89-311

View looking northwest  
Arrow points to bench mark



Figure 44a

Vista 89

View looking northwest  
Arrow points to bench mark

**Figure 45**



CVO89-310

View looking northwest  
Arrow points to bench mark

**Figure 45a**



CVO89-309

View looking south  
Arrow points to bench mark



**Figure 46**

CVO89-308

View looking east  
Arrow points to bench mark



**Figure 46a**

CVO89-307

View looking east  
Arrow at step ladder points to bench mark

**Figure 47**



CVO89-305

View looking east  
Arrow at step ladder points to bench mark

**Figure 47a**



CVO89-304

View looking south  
Arrow points to bench mark

Figure 48



CVO89-303

View looking northeast  
Arrow at step ladder points to bench mark



Figure 48a

CVO89-302

View looking north  
Arrow points to bench mark

**Figure 49**



CVO89-301

View looking southwest  
Arrow at step ladder points to bench mark

**Figure 49a**



CVO89-300

View looking southwest  
Arrow at step ladder points to bench mark

OLD MAMMOTH QUADRANGLE

NATIONAL CALIFORNIA FOREST

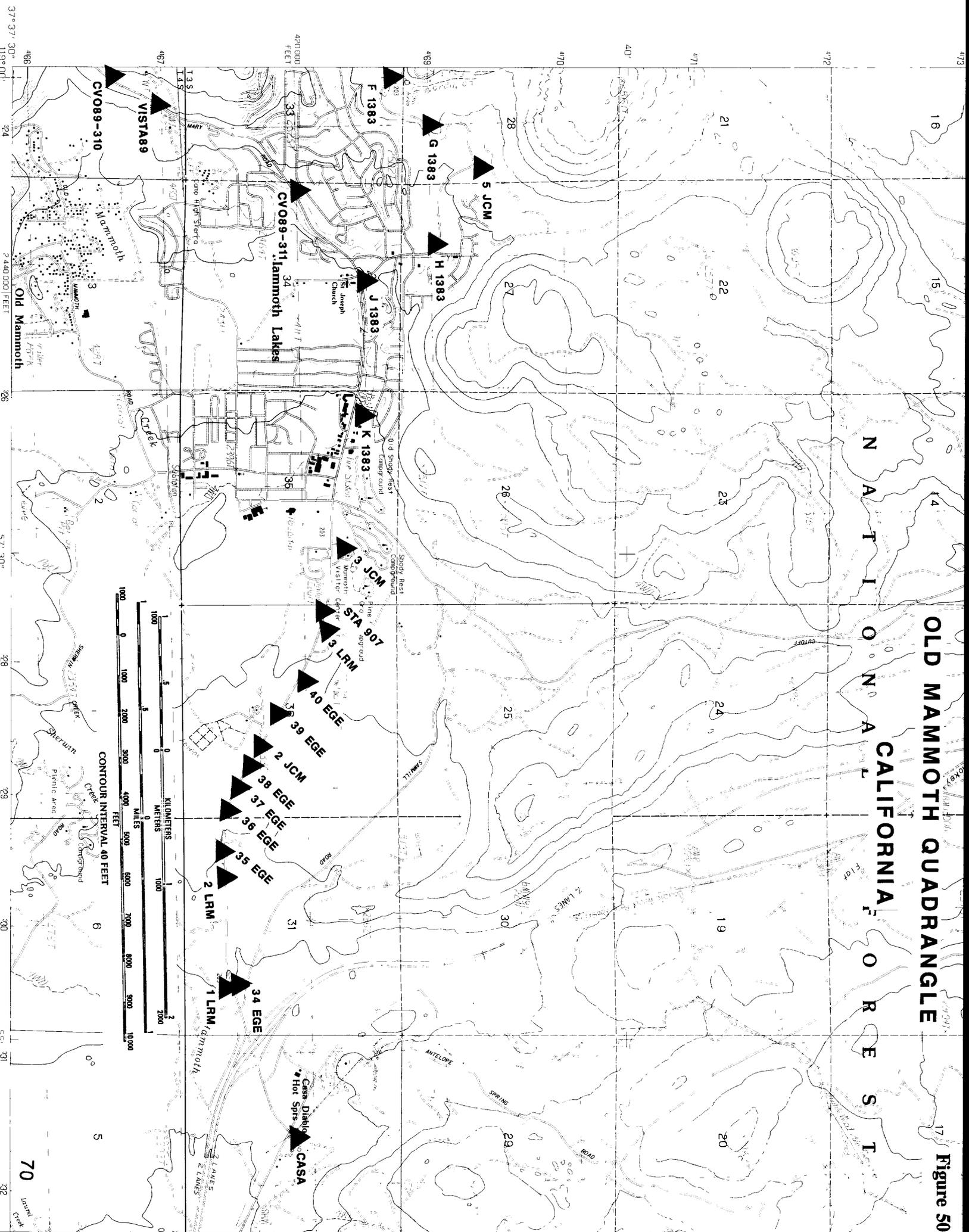
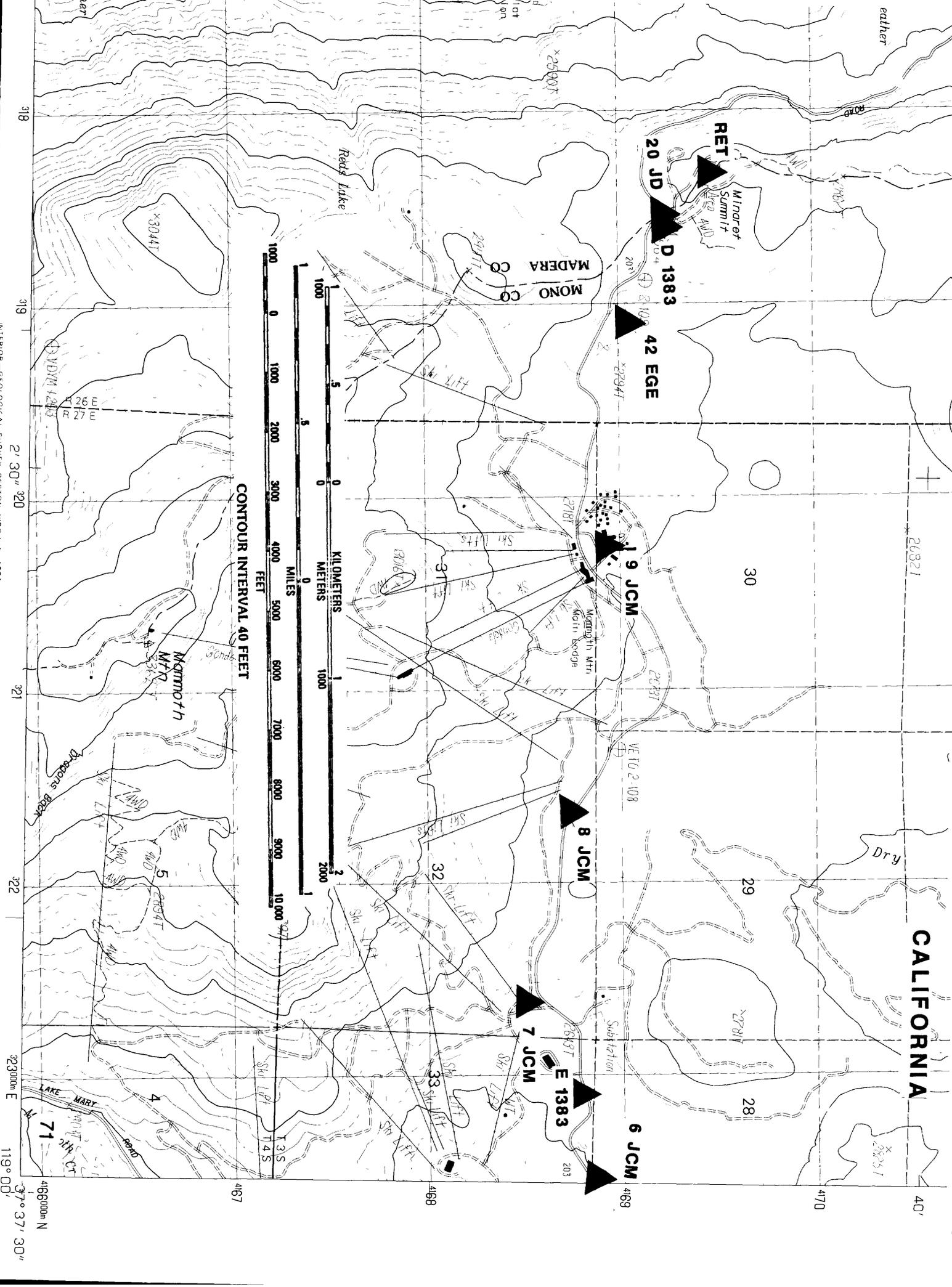


Figure 50

**MAMMOTH MTN QUADRANGLE**  
**CALIFORNIA**  
Figure 5



INTERIOR-GEOLOGICAL SURVEY RESTON VIRGINIA-1984

