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Geological Structures from Televiewer Logs of GT-2, Fenton Hill, New Mexico

Part 2: Rectification

Kerry L. Burns

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CONTENTS

ABSTRACT	1
I. INTRODUCTION	1
A. Scope of This Report	1
B. The Hot Dry Rock Geothermal Energy Program	2
C. Magnetic Field Vector.	2
D. Caliper Logs	3
E. Wellbore Survey	3
II. DIRECTIONS IN A WELLBORE	3
A. Direction Vectors.	3
B. Environmental Directions	4
C. Wellbore Direction	5
D. Structural Direction	5
E. Reference Direction.	6
F. Vertical Wellbore.	7
G. Inclined Wellbore.	7
H. Discussion	8
III. TRACES ON A WELLBORE	8
A. Trace in Wellbore Coordinates	8
B. Trace in Image Coordinates	10
C. Scanner Distortion	11
IV. DETERMINATION OF LOCATION.	12
A. Depth Calibration.	12
B. Relative Location.	12
C. Absolute Location.	12

V.	DETERMINATION OF ORIENTATION	13
A.	Inversion of Wellbore Trace	13
B.	Relative Orientation	14
C.	Rotation about an Inclined Axis	15
D.	Absolute Orientation	15
VI.	OBSERVED TEXTURES	16
A.	Drill Core Results	16
B.	Televiewer Results	16
VII.	LOCATION AND ORIENTATION	16
A.	Results from Drill Core	16
B.	Results from Televiewer	17
C.	Precision Rectification	18
VIII.	CONCLUSIONS.	19
	REFERENCES	40

GEOLOGICAL STRUCTURES FROM TELEVIEWER LOGS OF GT-2, FENTON HILL, NEW MEXICO

Part 2: Rectification

by

Kerry L. Burns

ABSTRACT

Televiewer logs from drill hole GT-2 at the Fenton Hill, New Mexico, Hot Dry Rock Site, have been rectified by conversion of structural traces on the scanner imagery to geographic location and orientation. The rectification method was direct inversion that consisted of mapping from the image to the wellbore, inverting the trace on the wellbore for principal points, and rotating from wellbore to geographic coordinates. From the test imagery of GT-2, 733 structures (fractures and foliations) were measured, compared with 42 structures from recovered core. The 733 new measurements listed in this report are a unique and unrepeatable collection of structural information from the Precambrian basement of northern New Mexico. This direct inversion method is accurate where the magnetic field vector is constant and the tool is centered and aligned in a circular wellbore. In other cases this method yields only approximate results.

I. INTRODUCTION

A. Scope of This Report

We have developed a method of extracting structural data from televiewer imagery using as trial data some extremely poor imagery from GT-2 at Fenton Hill. In Part 1 of this report, pattern recognition and pattern discrimination procedures on televiewer imagery were described. In Part 2 we describe methods of rectification, which means converting from image to external

coordinates and thereby determining the geographic location and orientation of structures. Quality control methods are described in Part 3. The rectification method is considered to be an improvement on Kierstein (1984), and the description is simpler.

B. The Hot Dry Rock Geothermal Energy Program

Drill hole GT-2 (Geothermal Test well No. 2) was drilled in 1974 to a total depth of 2932 m (9619 ft) at the Fenton Hill geothermal site in the Jemez Mountains of northern New Mexico (Pettitt 1975b). The upper 0.73 km was through a cover of volcanics and sediments and the remaining 2.27 km into a basement of Precambrian metamorphics, predominantly hornblende-biotite granite gneiss. This borehole, along with its neighbor EE-1 (Energy Extraction hole No. 1) was used, in 1975-1980, to prove the scientific feasibility of extracting energy from hydraulically fractured rock. This research program, the Hot Dry Rock Program, is currently continuing with hotter and deeper wells.

C. Magnetic Field Vector

The magnetic field vector at Fenton Hill for epoch 1965.0 (Gerlach 1970, p. 68) was declination 13°E of north, decreasing $2.5'$ per annum, and inclination 63° downward to the north, decreasing $2.5'$ per annum. The direction used in these computations was obtained by linear extrapolation to December 1974 and was a declination of $13^{\circ}36'\text{E}$ and an inclination of $62^{\circ}36'\text{N}$. The angle between this regional field vector and the wellbore axis averages 28° for the upper part of GT-2. Revised estimates of the field vector based on Gerlach (1970), Peddie, Jones, and Fabiano (1976), and Fabiano and Peddie (1980) are a declination of 12.2°E and an inclination of 63.7° , indicating a probable error of about 1° , which is negligible in this instance.

The magnetometer trigger for the televiewer scan lines becomes unreliable for an inclined hole that parallels the in situ field vector. The in situ field vector is the sum of the regional field, the remanence, and the induced magnetization vectors. The remanence vector is likely to vary from point to point due to an inhomogeneous structural-metamorphic history. The induced vector is likely to show a variation due to an inhomogeneous distribution of ferromagnetic minerals. Both the magnetometer sensitivity and the in situ field were unknown. If it is assumed that the in situ field is parallel to the regional field and that the magnetometer has a pointing accuracy of θ degrees, then the televiewer will be unreliable for holes that drift into a

cone of semiangle θ about the field vector. Since θ is likely to be considerably smaller than 28° , the magnetometer is reliable for the top part of GT-2.

D. Caliper Logs

Two caliper logs were available. The first was a Birdwell log of 11 July 1974 (run 5) (Pettitt 1975a, Fig. 18). The second was a Dresser-Atlas log of 11 February 1977. Both logs were consulted for hole diameter, but the Birdwell log seemed to match the televiewer data better. This is probably because it was run within a few months of the televiewer, before degradation of the wellbore. The nominal hole diameter was 9.63 in., but ranges up to 13 in. were found frequently.

E. Wellbore Survey

The GT-2 wellbore survey of Table I is GT2gyd, supplied by Zora Dash, Group ESS-4, Los Alamos. The GT-2 survey, a gyroscope survey, was reduced by the methods described in Callas, Novak, and Henderson (1979). Kierstein (1984) describes several other methods. Site datum was the NE corner of Sec. 13-T19N-R2E at 8700 ft above msl (mean sea level), and it was used as an origin for location. Drill hole GT-2 was collared at 1523.9 ft FEL, 1747.5 ft FNL, Sec. 13-T19N-R2E. The collar altitudes were 8689.9 GL (origin for depths), 8701.5 KB (original, see Pettitt 1975a, Fig. 3), 8697.5 KB (work-over rig), 8714.9 KB (Noble rig), where GL = ground level, KB = Kelly bushing, FEL = from east line, FNL = from north line. The televiewer footages on imagery (fiducial values) referred to the origin at ground level, 8689.9 msl.

II. DIRECTIONS IN A WELLBORE

A. Direction Vectors

Direction vectors are unbound unit vectors. Let $\underline{v}$ denote a column three vector; that is, $\underline{v} = [v_1, v_2, v_3]'$ where ' indicates transpose. Let the operators $\cdot$, $\times$, and norm indicate scalar product, vector product, and normalization (reduction to unit length), respectively, as in $\underline{w} = \underline{u} \cdot \underline{v}$, $\underline{w} = \underline{u} \times \underline{v}$ and $\underline{u} = \text{norm}(\underline{v})$. The geometrical relations of a geological structure in an inclined wellbore in a deviated magnetic field may be described in terms of direction vectors as shown in perspective in Figure 1. The geometrical arrangement of directions in three dimensions is shown in the stereographic projections of Figures 2 and 3. Figure 2 is the projection for a vertical hole;

TABLE 1: REDUCED WELLBORE SURVEY, GT-2 (from Zora Dash, Los Alamos)

Depth Downhole (ft)	Orientation		Location		
	Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)
2500	317.27	88.65	-1734.36	-1543.45	2504.58
2600	313.98	88.57	-1732.62	-1545.13	2604.55
2700	314.85	88.52	-1730.85	-1546.95	2704.51
2800	313.70	88.33	-1728.91	-1548.97	2804.48
2900	310.27	88.20	-1726.86	-1551.21	2904.43
3000	302.13	88.10	-1725.07	-1553.82	3004.38
3100	297.47	88.33	-1723.48	-1556.51	3104.33
3200	293.67	88.20	-1722.13	-1559.25	3204.28
3300	287.50	88.60	-1721.28	-1561.55	3304.25
3400	277.25	88.67	-1720.86	-1563.85	3404.23
3500	268.37	88.58	-1720.80	-1566.21	3504.20
3600	277.645	88.565	-1720.685	-1568.68	3604.165
3700	287.97	88.43	-1720.13	-1571.13	3704.13
3800	286.98	88.15	-1719.22	-1574.01	3804.09
3900	284.83	87.97	-1718.27	-1577.27	3904.03
4000	284.72	87.83	-1717.30	-1580.85	4003.96
4100	287.02	87.72	-1716.30	-1584.55	4103.89
4200	288.685	87.585	-1714.975	-1588.55	4203.80
4300	290.35	87.45	-1713.65	-1592.55	4303.71
4400	288.65	87.77	-1712.20	-1596.48	4403.62
4500	286.43	87.67	-1711.54	-1600.39	4503.54
4600	286.30	87.78	-1709.80	-1604.18	4603.46
4700	286.37	87.90	-1708.72	-1607.78	4703.39

Figure 3 for an inclined hole. This set of directions varies in some important respects from that of Kierstein (1984).

B. Environmental Directions

The direction vertically down is $\underline{g}$, the gravity vector. The north-seeking direction of the magnetic field is $\underline{n}$, the magnetic vector. The magnetic meridian is a plane defined by its normal $\underline{m}$, as shown in Figure 1, where $\underline{m} = \underline{g} \times \underline{n} = [\cos d, \sin d, 0]$, where d is the true azimuth of magnetic north.

Figure 1. Perspective view of a plane structure intersecting a wellbore. The unit vector $\underline{p}$ is normal to the plane, $\underline{s}$ is the right-handed strike direction, and $\underline{t}$ is the dip direction. The axis of the wellbore has direction $\underline{h}$. The center of the plane is where the axis of the wellbore intersects the plane; the magnetic meridian through the center has normal direction $\underline{m}$. The intersection of planes normal to $\underline{p}$ and $\underline{h}$ is a space curve. For a plane structure, centered televiewer, and circular wellbore, the space curve reduces to an ellipse with semiaxes $\underline{s}$ and $\underline{t}$, where $\underline{s} = \underline{h} \times \underline{p}$, $\underline{t} = \underline{p} \times \underline{s}$.

C. Wellbore Direction

The orientation of a drill hole is defined by the vector $\underline{h}$ that points down the axis of the hole, as shown in Figure 1. If the hole is a quadric cylinder, then $\underline{h}$ is the axis of the cylinder or a generator of the cylinder. If a televiewer tool is properly aligned with the wellbore, the axis of rotation of the transducer is parallel to the axis of the hole. Then the plane normal to $\underline{h}$ is the plane of rotation of the transducer and the scanner traces where this plane intersects the wellbore. On every revolution of the transducer, the magnetometer senses the position of the magnetic meridian. One method is to sense the change of magnetic polarity from negative to positive as the axis of the magnetometer sweeps through the magnetic azimuth of 270° . It is convenient to think of a "trigger" being tripped whenever the transducer sweeps through the magnetic azimuth of 360° . The trigger direction or the meridian trend on the scanner trace is then $\underline{u}$ where $\underline{u} = \underline{h} \times \underline{m}$.

D. Structural Direction

The orientation of a plane discrete structure is defined by the orientation vector $\underline{p}$ that points normal to the plane, positive down. For a wellbore

Figure 2. Stereographic projection (Wulff, equal-angle or conformal projection) showing directions associated with a vertical wellbore. Horizon (geographic) directions are MN, E, S, W (magnetic north, east, south, and west). Direction vectors are $\underline{f}$, $\underline{g}$, $\underline{h}$, $\underline{m}$, $\underline{n}$, $\underline{r}$, $\underline{s}$, $\underline{t}$, $\underline{u}$, $\underline{v}$, $\underline{p}$, and $\underline{q}$. Cyclographic traces are F, H, M, S, P, and G. Dihedral angles are ϕ and θ .

with the shape of a circular cylinder, the trace of the structure on the wall is an ellipse in the plane normal to $\underline{p}$ (Goodman 1976, p. 143) with axes $\underline{s}$ ($= \underline{h} \times \underline{p}$) and $\underline{t}$ ($= \underline{p} \times \underline{s}$), as shown in Figure 1. The direction $\underline{q}$ ($= \underline{p} \times \underline{m}$) or the meridian trend on the structural trace is the direction of the intersection of the magnetic meridian and the structural plane.

E. Reference Direction

It is convenient to define a reference or auxiliary plane with normal $\underline{f}$ defined by $\underline{f} = \underline{u} \times \underline{h}$. This plane contains the axis of the hole and the trigger direction. It intersects the structure in the reference direction, $\underline{r}$ ($= \underline{p} \times \underline{f}$), or the reference trend on the structure trace.

Figure 3. Stereographic projection showing directions associated with an inclined wellbore. Labels as for Figure 2.

F. Vertical Wellbore

Figure 2 is a stereographic projection for a vertical wellbore, that is, for the case $\underline{h} = \underline{g}$. Three independent directions are $\underline{h}$, $\underline{m}$, and $\underline{p}$, with corresponding cyclographic traces H, M, and P. Derived directions in the plane are $\underline{s}$, $\underline{t}$, and $\underline{q}$ as defined above. Derived directions on a scan line are $\underline{u}$ and $\underline{v}$, defined by $\underline{u} = \underline{h} \times \underline{m}$ and $\underline{v} = \underline{h} \times \underline{s}$. In a vertical wellbore the directions $\underline{f}$ and $\underline{r}$ are defined by the degeneracies $\underline{f} = \underline{m}$ and $\underline{r} = \underline{q}$.

G. Inclined Wellbore

Figure 3 is a stereographic projection for an inclined wellbore. Four independent directions are $\underline{g}$, $\underline{h}$, $\underline{m}$, and $\underline{p}$, with corresponding cyclographic traces G, H, M, and P. Derived directions are $\underline{s}$, $\underline{t}$, $\underline{q}$, $\underline{u}$, and $\underline{v}$, as before. The reference plane is defined by its normal, $\underline{f}$, where $\underline{f} = \underline{u} \times \underline{h}$, and the reference direction in the structural trace is defined by $\underline{r} = \underline{p} \times \underline{f}$. If the

wellbore is vertical, $\underline{g} = \underline{h}$. Then $\underline{f} = \underline{u} \times \underline{h} = (\underline{g} \times \underline{m}) \times \underline{h}$ becomes $(\underline{h} \times \underline{m}) \times \underline{h} = \underline{m}$, and $\underline{r} = \underline{p} \times \underline{f}$ becomes $\underline{p} \times \underline{m} = \underline{q}$, which are the degeneracies previously noted for the vertical case.

H. Discussion

The list of orientation (unit) vectors is as follows:

- $\underline{g}$: gravity vector, positive down.
- $\underline{n}$: magnetic vector, positive north.
- $\underline{m} = \underline{g} \times \underline{n}$: normal to the magnetic meridian plane, positive east.
- $\underline{h}$: axis of drill hole, positive down.
- $\underline{u} = \underline{h} \times \underline{m}$: meridian direction on scanner trace.
- $\underline{f} = \underline{u} \times \underline{h}$: normal to reference plane.
- $\underline{p}$: normal to structural plane, positive down.
- $\underline{q} = \underline{p} \times \underline{m}$: meridian direction on structural plane.
- $\underline{r} = \underline{p} \times \underline{f}$: reference direction in structure.
- $\underline{s} = \underline{h} \times \underline{p}$: strike direction, positive if right-handed.
- $\underline{t} = \underline{p} \times \underline{s}$: dip direction, positive down-dip.
- $\underline{v} = \underline{h} \times \underline{s}$: trend of dip direction.

This set of directions is more complex than that of Kierstein (1984). The difference is the introduction of the vertical reference plane, $\underline{f}$, as different from the (vertical) meridian plane, $\underline{m}$. The two are parallel only if the wellbore azimuth is magnetic north. Kierstein's results are regarded as applicable only to this special case.

III. TRACES ON A WELLBORE

The intersection of a geological structure with an inclined wellbore in a deviated magnetic field may be described in terms of a structural trace, which is a space curve formed at the intersection of two three-dimensional surfaces, the plane structure and the cylindrical wellbore. The intersection is shown in a perspective diagram, Figure 1.

A. Trace in Wellbore Coordinates

The trace of a plane structure on the wall of a circular drill hole is, in three dimensions, an ellipse in the plane $\underline{p}$ with axes $\underline{s} = \underline{h} \times \underline{p}$ and $\underline{t} = \underline{p} \times \underline{s}$ (Figure 1). The trace of a structure on a wellbore is illustrated in Figure

4. Figure 4 is a cylindrical projection of the inside of the wellbore looking along $\underline{u}$ ($= \underline{h} \times \underline{m}$) at the origin, with the Y-axis parallel to $\underline{h}$ and with the remainder of the figure "unrolled" about $\underline{h}$. In this projection, the trace of a plane structure is the harmonic curve:

$$y - y_1 = C + A \cos (x - x_1) + B \sin (x - x_1) \quad . \quad (1)$$

Figure 4. Cylindrical projection about the wellbore axis showing the trace of a plane structure on the wellbore. The coordinates (x, y) are azimuth and altitude, respectively, in wellbore coordinates. Generators of the wellbore are $x = \text{constant}$. Traces through $\underline{u}$ are M, the magnetic meridian; F, the reference plane; P, the structure trace; and H, the plane normal to the axis of the borehole. The projection of the right-handed strike direction is (x_4, y_3) and of the dip direction is (x_5, y_2) , which correspond to directions $\underline{s}$ and $\underline{t}$ of Figure 2.

The strike of a plane is defined right-handedly; that is, of the two antipodal directions for strike, we choose as positive that for which the plane is rotated downward to the right. The dip line, $\underline{t}$, is the direction of steepest descent in the plane. For a televiewer rotating right-handedly about the well-bore axis, $\underline{h}$, the projections from Figure 1 to Figures 4 and 5, and to Figures 2 and 3, are

$$\begin{array}{ll}
 & : \underline{u} \text{ ---> } (x_1, y_3) : \text{reference direction} \\
 \text{strike line} & : \underline{s} \text{ ---> } (x_4, y_3) : \text{descending node} \\
 \text{antistrike} & : \quad \quad (x_2, y_3) : \text{ascending node} \\
 \text{dip line} & : \underline{t} \text{ ---> } (x_5, y_2) : \text{minimum turning point} \\
 \text{antidip} & : \quad \quad (x_3, y_4) : \text{maximum turning point} \\
 \text{trend of dip} & : \underline{v} \text{ ---> } (x_5, y_3) \\
 \underline{r} : \text{reference crossing} & \underline{q} : \text{meridian crossing}
 \end{array} \tag{2}$$

The terminology used is $\underline{h}$ for a direction (unit vector), H or trace (H) for the plane normal to $\underline{h}$ (the projective dual of Gans 1969, p. 240), and ---> for a projective mapping.

B. Trace in Image Coordinates

The rotary televiewer rotates about $\underline{h}$ with each scan line being triggered at the point where it crosses the magnetic meridian. In the resultant image (Figure 5), the lines $y = \text{constant}$ are scan lines, and the points $w = w_u$ in each scan line are the meridian crossing points. The lines $x = \text{constant}$ are cylindroidal generators (that is, generators of a quadric cylinder) that run parallel to the axis of the borehole. On televiewer imagery the trace, y , of a plane structure is an implicit function of w given by

$$y - y_1 = C + A \cos(x - x_1) + B \sin(x - x_1)$$

and

$$w - w_u = (x - x_1) + (y - y_1 - C) \tan \theta; \tag{3}$$

$$\cos \theta = \{ \text{norm}[(\underline{m} \times \underline{h}) \times \underline{m}] \} \cdot \underline{h} . \tag{4}$$

Figure 5. Appearance of a structural trace on a televiwer image. The coordinates (w, y) are azimuth and altitude, respectively, in the image. Scan lines are $y = \text{constant}$, $0^\circ \leq w \leq 360^\circ$. The locus of the magnetic meridian on the scan lines is the scan-line trigger, $w = w_u$. Labels are as for Figure 4.

The $\times$, $\cdot$, and norm indicate vector product, scalar product, and normalization, respectively. The definition of angle θ given in Equation (4) is for a tool rotating right-handedly about the positive direction (down) of $\underline{h}$.

C. Scanner Distortion

The difference between Equations (1) and (3) constitutes an intrinsic scanner distortion. The transformation is affine; it does not displace inflection points but does displace turning points. For this part of GT-2, the distortion error is small, the average value being about 1.2° . The error in orientation is less than 0.01° for a typical structure and is not corrected.

IV. DETERMINATION OF LOCATION

A. Depth Calibration

Depths are usually expressed in relation to a standard survey obtained from the location of collars on the drill string. Depths obtained with cable tools, such as the televiewer, depart from the standard mainly because of cable stretch. If $\{c_i; i = 1, B\}$ is a set of cable tool depths for which matching points $\{b_i; i = 1, B\}$ have been found on a collar log, then the calibrated depth of the televiewer, d , is given by a calibration function $d = P(c)$ defined by the requirement that $b_i = P(c_i)$ for $i = 1, B$. This statement leads to a polynomial calibration function (e.g., Adey and Brebbia 1982, p. 179). Alternatively, a Green's (influence) function $G(c, b)$ can be defined so that $G(c, b) = 1$ if $c = b$ and d is found as a weighted sum of influences of the type $G(c, b_i); i = 1, B$. Watson (1984) shows that Green's functions lead to cubic splines, which under some conditions are equivalent to Kriging. For GT-2, we use the reduced wellbore survey GT2yd and piecewise-linear interpolation. For depth calibration in EE-3A, it was useful to plot the televiewer data as the scalar function $1/z$ versus depth, where $z = \sqrt{A^2 + B^2}$, for comparison with caliper and gamma logs, as the physical effect of a structure varies inversely with the amplitude of its trace.

B. Relative Location

The relative or image location is the point at which the structure crosses the axis of the wellbore, in coordinates attached to the wellbore axis. If b_1 is the calibrated depth downhole of the base of the scanner image, then the relative location of the structure is given by $b_3 = b_1 - (y_3 - y_1)$. If the fiducial marks are nominated in depths downhole, that is, assigned altitudes in terms of calibrated depth downhole, then from Equation (1), $b_3 = C$.

C. Absolute Location

Let b_6 and b_7 be depths downhole, measured along the drill string, of two survey points on the drill hole where the wellbore inclination vectors $\underline{h}_6$ and $\underline{h}_7$ and location vectors $\underline{z}_6$ and $\underline{z}_7$ are known from a reduced hole survey. Linear interpolation then yields the location vector, $\underline{z}$, and hole inclination vector, $\underline{h}$, where

$$(h - \underline{h}_7)/(\underline{h}_6 - \underline{h}_7) = (z - \underline{z}_7)/(\underline{z}_6 - \underline{z}_7) = (b_3 - b_7)/(b_6 - b_7) \quad .$$

Linear interpolation is found to be sufficiently accurate if

$$\max\{|b_3 - b_7|, |b_6 - b_7|, |b_6 - b_3|\} \leq 100 \text{ ft} \quad .$$

V. DETERMINATION OF ORIENTATION

A. Inversion of Wellbore Trace

The principal points on the trace of Figure 4 are the ascending and descending nodes and maximum and minimum turning points. Equation (1) may be inverted to yield the azimuth of the descending node, in wellbore coordinates, as follows. The ascending and descending nodes in Figure 4 correspond to positive and negative first derivatives of Equation (1) so that, for $x_1 = 0$,

$$dy/dx = -A \sin x + B \cos x > 0 \quad \text{ascending node} \quad (5)$$

and

$$dy/dx = -A \sin x + B \cos x < 0 \quad \text{descending node} \quad . \quad (6)$$

The nodes are at zeros in the second derivative; thus,

$$d^2y/dx^2 = -A \cos x - B \sin x = 0 \quad . \quad (7)$$

The solution to Equation (7) is found, after some manipulation, to be

$$x = 180 n + \text{atn}(-A/B); \quad n = 0, 1 \quad , \quad (8)$$

where atn returns in the range -90° to $+90^\circ$. The problem of finding the descending node is then to choose n appropriate to Equation (6). The result is $n = [1 + \text{sgn}(B)]/2$, where $\text{sgn}(B)$ is the sign of B . By similar arguments the set of principal points on the trace is obtained as

$$\begin{aligned}
 \text{ascending node} & : \quad x_2 - x_1 = 180 n_2 + \text{atn}(-A/B) \\
 & \quad n_2 = [1 - \text{sgn}(B)]/2 \\
 \text{maximum turning point} & : \quad x_3 - x_1 = 180 n_3 + \text{atn}(B/A) \\
 & \quad n_3 = [1 - \text{sgn}(A)]/2 \\
 \text{descending node} & : \quad \underline{s}: x_4 - x_1 = 180 n_4 + \text{atn}(-A/B) \\
 & \quad n_4 = [1 + \text{sgn}(B)]/2 \\
 \text{minimum turning point} & : \quad \underline{t}: x_5 - x_1 = 180 n_5 + \text{atn}(B/A) \\
 & \quad n_5 = [1 + \text{sgn}(A)]/2
 \end{aligned} \tag{9}$$

B. Relative Orientation

Relative to a drill hole axis pointing vertically down and a magnetic meridian intersecting the wellbore at $(x, y) = (x_1, y_3)$, as in Figure 4, the orientation of the structural plane, where a is the borehole radius (from a caliper log), is given by

- (i) Relative strike: $\emptyset = x_4 - x_1$. This is the azimuth of $\underline{s}$ in H , measured right-handedly about $\underline{h}$.
- (ii) Relative dip: $\theta = \text{atn}(|y_3 - y_2|/a)$. This is the dihedral angle from $\underline{h}$ to $\underline{p}$, measured right-handedly about $\underline{s}$.
- (iii) Trend of dip: $90 + \emptyset = x_5 - x_1$. This is the azimuth of $\underline{v}$ in H , measured right-handedly about $\underline{h}$.

(10)

C. Rotation about an Inclined Axis

A rigid right-handed rotation through an angle of θ° about an axis (unit vector) $\underline{a}$ may be written (Burns and Murdoch 1983) as the operator $R(\underline{a}, \theta)$:

$$R(\underline{a}, \theta) = [(\cos \theta)I_3 + (1 - \cos \theta) \underline{a} \cdot \circ \underline{a}' + (\sin \theta) \underline{a} \cdot \times \underline{a}'] ,$$

$$\text{where } \underline{a} \cdot \circ \underline{a}' = \begin{vmatrix} a_1 a_1 & a_1 a_2 & a_1 a_3 \\ a_2 a_1 & a_2 a_2 & a_2 a_3 \\ a_3 a_1 & a_3 a_2 & a_3 a_3 \end{vmatrix} \text{ and } \underline{a} \cdot \times \underline{a}' = \begin{vmatrix} 0 & -a_3 & a_2 \\ a_3 & 0 & -a_1 \\ -a_2 & a_1 & 0 \end{vmatrix} .$$

R is a general screw rotation (MacMillan 1936, p. 167; Burns and Murdoch 1983). The elementary operators $\cdot \circ \cdot$ and $\cdot \times \cdot$ are the "outer-product" and "cross-product" operators, respectively. The operation of R on $\underline{x}$ to yield $\underline{y}$ will be written $\underline{y} = R(\underline{a}, \theta) \underline{x}$.

D. Absolute Orientation

The Relations (2) and (10) define the projection from Figures 4 and 5 to Figures 2 and 3, that is, from the scanner image to the spherical projection. Define orientation (unit) vectors as follows, normalized to unity where necessary:

- $\underline{g}$: gravity vector (positive down).
- $\underline{n}$: magnetic vector (positive north).
- $\underline{m} = \underline{g} \times \underline{n}$: normal to the magnetic meridian plane (positive east).
- $\underline{h}$: axis of drill hole (positive down).
- $\underline{u} = \underline{h} \times \underline{m}$: reference direction on scanner trace.
- $\underline{f} = \underline{u} \times \underline{h}$: normal to reference plane.
- $\underline{p}$: normal to structural plane (positive down).
- $\underline{r} = \underline{p} \times \underline{f}$: reference direction in structure.
- $\underline{s} = \underline{h} \times \underline{p}$: minor axis of elliptical trace.
- $\underline{t} = \underline{p} \times \underline{s}$: major axis of elliptical trace.
- $\underline{v} = \underline{h} \times \underline{s}$: trend of dip line.

Note that $(\underline{s}, \underline{r}, \underline{t})$ are coplanar, normal to $\underline{p}$, and similarly for $(\underline{s}, \underline{u}, \underline{v})$, $\underline{h}$; $(\underline{h}, \underline{r}, \underline{u})$, $\underline{f}$; and $(\underline{n}, \underline{g}, \underline{u})$, $\underline{m}$. Note also that $(\underline{s}, \underline{t})$ are perpendicular to each other in the plane normal to $\underline{p}$, and similarly for $(\underline{s}, \underline{v})$, $\underline{h}$ and $(\underline{h}, \underline{u})$,

f. We are given g, n from regional observations, h from a reduction of the borehole survey, and information on s, t, u, v from the scanner trace, and we are required to find p. The procedure is described in algorithm 1, below. This method is much shorter than Kierstein's (1984, pp. 6-16).

Algorithm 1:

- (i) Find the orientation of the reference direction on the scanner trace from $\underline{u} = \text{norm} [(\underline{g} \times \underline{n}) \times \underline{h}]$.
- (ii) Since u and s are coplanar, normal to h, and the angle between u and s is θ , find $\underline{s} = R(\underline{h}, \theta) \underline{u}$.
- (iii) Since u and v are coplanar, normal to h, and the angle between u and v is $(90 + \emptyset)$ degrees, find $\underline{v} = R(\underline{h}, 90 + \emptyset) \underline{u}$.
- (iv) Since v and t are coplanar, normal to s, and the angle between v and t is θ , find t as $\underline{t} = R(\underline{s}, \theta) \underline{v}$.
- (v) Finally, p is found as $\underline{p} = \underline{s} \times \underline{t}$.

VI. OBSERVED TEXTURES

A. Drill Core Results

The textural identifications of Laughlin et al. (1983), from inspection of drill core, are listed in Table II.

B. Televiewer Results

As far as possible, structures were identified by textural type, such as joints, faults, layerings, veins, foliation (gneissosity and schistosity), and cleavage. Structures such as fold closures or traces of lineations could not be distinguished. The textural names are listed in Table III.

VII. LOCATION AND ORIENTATION

A. Results from Drill Core

The orientations in Table IV were obtained by digitization of Figures 5 and 8 in Laughlin et al. (1983). These are lower-hemisphere Lambert projections with the transformation of colatitude $(90^\circ - e)$ given by (Vistelius 1966): $r_e = \text{sqrt}(2) r_0 \sin(45^\circ - e/2)$, where r_e is the radius corresponding

TABLE II: TEXTURAL NAMES FROM RECOVERED CORE, DRILL HOLE GT-2
 [from Laughlin et al. (1983)]
 (This is an index to names in Table IV.)

F = foliation (gneissosity & schistosity)
 Ju = unhealed fracture
 Jh = healed fracture
 Jp = fracture with pyrite filling

to a colatitude of $90^\circ - e$ on the projection and r_0 is the radius for $90^\circ - e = 90^\circ$.

B. Results from Televiwer

The subsurface information from Fenton Hill is unique and irreplaceable. Precambrian rocks outcrop at the surface in the Picuris Range, Truchas Range, Nacimiento uplift, and Sandia Mountains about 65 km E, 65 km NE, 13 km W, and 65 km SSE, from Fenton Hill. The relationship between these occurrences is conjectural. The Fenton Hill subcrop lies centrally between these four outcrops, and information from Fenton Hill may well be critical to understanding Precambrian relationships in this part of New Mexico. For this reason, the results are tabulated in Tables V and VI. Table V lists results from run 1,

TABLE III: TEXTURAL NAMES FROM TELEVIEWER LOGS OF GT-2
 (This is an index to names in Tables V and VI.)

J = joint, probably
 Js = joint with chattermark
 (spalling or chipping on the trace)
 Jf = fault or boundary of fracture system
 J? = joint, possibly
 F = foliation
 Fs = foliation with chattermark
 (thin micaceous seam?)
 Fl = lithological layering
 F? = foliation, possibly
 C = cleavage, probably
 Cs = cleavage with chattermark
 (crenulation cleavage?)
 C? = cleavage, possibly
 V? = vein, possibly

TABLE IV: ORIENTATIONS OF STRUCTURES IN DRILL CORE, GT-2. FOLIATIONS FROM DEPTH RANGE 1126-1129 m. FRACTURES FROM DEPTH RANGES 1127-1129, 1304-1306, and 1672-1674 m [from Laughlin et al. (1983)]

No.	Orientation		Type
	Azimuth (deg)	Inclination (deg)	
1	144	71.3	F
	161	52.0	F
	168	60.5	F
4	176	63.8	F
5	184	58.0	F
	196	45.3	F
	201	49.5	F
	218	73.7	F
9	004	1.1	Ju
10	028	2.3	Ju
	040	81.9	Ju
	110	11.0	Ju
	111	8.8	Ju
14	123	61.3	Jh
15	134	77.0	Jh
	134	70.3	Jh
	141	5.6	Ju
	144	6.5	Ju
19	146	65.2	Ju

for depths of 2536-2670 ft and 2690-4270 ft. Table VI lists results for run 2, 4000-5600-ft and 6260-6340-ft depths downhole. The accuracy of these measurements is discussed in Part 3 of this report.

C. Precision Rectification

Rectification by the sequential processing method used here is satisfactory for GT-2 because of the small angle between the axis of the hole and the plane of the magnetic meridian. However, in general, the method is only approximate because the magnetic vector and hole inclination vector are required for fitting a trace; finding these vectors requires a knowledge of depth downhole that is not known before fitting a trace. Iterative procedures that consider all inputs simultaneously are required for determining location precisely. These procedures are likely to be quite elaborate and will require simultaneous consideration of digitized televiewer imagery, caliper and collar logs. Because of the impulsive nature of caliper data and their large effect

TABLE IV (cont)

No.	Orientation		Type
	Azimuth (deg)	Inclination (deg)	
20	150	68.0	Ju
	150	64.7	Jh
	150	60.7	Ju
	169	2.3	Jh
24	174	58.7	Jh
25	180	72.9	Jh
	211	34.4	Ju
	222	11.0	Ju
	242	20.1	Ju
29	243	67.7	Ju
30	251	22.1	Ju
	269	21.1	Jp
	276	52.9	Ju
	286	17.1	Ju
34	297.5	15.1	Ju
35	302.5	34.2	Ju
	309.5	20.1	Ju
	311	20.1	Ju
	311	18.1	Ju
39	313.5	6.7	Ju
40	314	20.1	Ju
	317	5.4	Ju
42	319.5	2.3	Ju

on the estimated dip, precision orientations are difficult by any method requiring correlation between logs, and high precision requires that the televiewer be run simultaneously with a caliper, hole inclinometer, and magnetometer.

VIII. CONCLUSIONS

Rectification comprises calibrating depth, finding principal points on the structural trace, and rotating to geographic coordinates using rigid screw rotations. From the test imagery of GT-2, 733 structures (fractures and foliations) were measured, compared with 42 structures from recovered core. The 733 new measurements are listed in Tables V and VI. These measurements are a

unique and unrepeatable collection of structural information from the Precambrian basement of northern New Mexico. The method used for determining depth for GT-2 was linear interpolation between points estimated by the methods of Callas, Novak, and Henderson (1979). Nonlinear methods, such as cubic splines, based on the actual survey points would be preferable. The method of determining orientation was a direct method that assumed the tool was centered and aligned in a circular wellbore, the structure was plane, and the magnetic field vector was constant. The instrument used in GT-2 did not provide sufficient information to support a more sophisticated model able to take account of distorting factors such as tool off-centering, tool misalignment, tool oscillations, hole noncylindricity, magnetic field inconstancy, and structural nonplanarity, so precise measurements were not possible. More powerful instruments are desirable. In the absence of information on the distorting factors, direct evaluation of the likely size or type of errors is not possible, and it is necessary to use indirect methods to assess errors. An analysis of data quality is given in Part 3 of this report.

TABLE V: LOCATION AND ORIENTATION OF STRUCTURES IN TELEVIEWER RUN 1,
FROM 2536 TO 4263 ft^a

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
1	2536.63	326.79	2.47	-1733.72	-1544.07	2541.2	F	0.01
	2536.71	195.27	15.74	-1733.72	-1544.07	2541.28	J	0.02
	2538.22	328.05	2.83	-1733.7	-1544.09	2542.78	F	0.01
	2541.33	325	4.46	-1733.64	-1544.14	2545.9	F	0.03
	2542.43	280.96	12.34	-1733.62	-1544.16	2547	J	0.1
	2550.49	85.1	6.23	-1733.48	-1544.3	2555.06	Js	0.03
	2556.37	240.5	2.97	-1733.38	-1544.4	2560.93	Js	0.05
	2563.32	73.33	15.39	-1733.26	-1544.51	2567.89	J	0.09
9	2570.2	242.29	34.87	-1733.14	-1544.63	2574.75	J	0.28
10	2587.65	242.34	5.84	-1732.83	-1544.92	2592.2	Js	0.06
	2587.71	249.11	15.31	-1732.83	-1544.92	2592.27	J	0.06
	2590.55	271.01	8.55	-1732.78	-1544.97	2595.1	J	0.16
	2595.24	267.65	16.44	-1732.7	-1545.05	2599.79	J	0.14
	2612.71	336.22	3.63	-1732.39	-1545.36	2617.26	Js	0.06
	2617.46	53.2	13.78	-1732.31	-1545.45	2622	J	0.13
	2622.52	269.9	5.23	-1732.22	-1545.54	2627.06	Cs	0.12
	2638.77	66.59	5.67	-1731.93	-1545.84	2643.31	J	0.11
	2643.36	321.25	3.11	-1731.85	-1545.92	2647.9	Fs	0.07
19	2649.56	267.43	7.94	-1731.74	-1546.03	2654.09	J	0.05
20	2664.85	12.45	5.38	-1731.47	-1546.31	2669.38	Js	0.11
	2665.54	295.83	1.31	-1731.46	-1546.32	2670.06	J	0.04
	2697.05	96.55	6.45	-1730.9	-1546.9	2701.56	J	0.04
	2697.36	214.76	12.67	-1730.9	-1546.9	2701.87	J?	0.07
	2700.6	264.9	27.52	-1730.84	-1546.96	2705.11	J	0.07
	2706.87	261.28	2.54	-1730.73	-1547.08	2711.38	J	0.03
	2718.28	240.68	7.24	-1730.5	-1547.32	2722.78	F	0.06
	2720.5	277.66	17.52	-1730.45	-1547.36	2725.01	J	0.08
	2724.7	266.66	19.7	-1730.37	-1547.45	2729.2	J	0.08
29	2727.16	258.67	19.77	-1730.32	-1547.5	2731.66	Jf	0.14
30	2736.83	241.55	10.79	-1730.14	-1547.69	2741.33	F	0.09
	2737.44	253.62	10.65	-1730.12	-1547.71	2741.93	F	0.05
	2738.47	257.56	10.03	-1730.1	-1547.73	2742.97	J	0.11
	2754.86	75.9	13.09	-1729.79	-1548.06	2759.35	J	0.12
	2758.87	263.2	2.93	-1729.71	-1548.14	2763.36	C	0.02
	2761.14	69.98	15.88	-1729.66	-1548.18	2765.63	J	0.03
	2762.73	83.02	12.03	-1729.63	-1548.22	2767.22	J	0.02
	2770.55	70.58	15.72	-1729.48	-1548.38	2775.04	J	0.04
	2771.83	59.38	15.29	-1729.46	-1548.4	2776.31	Js	0.07
39	2772.04	68.97	15.66	-1729.45	-1548.41	2776.53	Js	0.09

^aOrientations refer to the pole to the plane, that is, the unit vector normal to the plane. Azimuths are degrees east of true north; inclinations are positive down (degrees below the geographic horizon).

TABLE V (cont)

Depth Downhole No.	Depth (ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
40	2786.45	17.9	4.33	-1729.17	-1548.7	2790.94	V?	0.08
	2787.53	71.73	15.54	-1729.15	-1548.72	2792.02	J	0.07
	2787.88	104.92	7.5	-1729.15	-1548.73	2792.36	C	0.01
	2800.89	256.59	8.95	-1728.89	-1548.99	2805.37	C	0.1
	2803.24	59.24	34.9	-1728.85	-1549.04	2807.72	F	0.11
	2805.83	286.96	37.02	-1728.8	-1549.09	2810.31	F	0.1
	2815.87	140.95	20.57	-1728.58	-1549.33	2820.34	J	0.04
	2825.75	98.11	23.73	-1728.38	-1549.55	2830.22	Js	0.14
	2828.96	125.46	24.28	-1728.32	-1549.62	2833.42	J	0.03
49	2829.03	257.42	34.85	-1728.31	-1549.62	2833.49	Js	0.12
50	2829.19	350.44	14.54	-1728.31	-1549.62	2833.66	Js	0.04
	2830.85	79.16	12.3	-1728.28	-1549.66	2835.31	J	0.04
	2836.24	50.46	18.38	-1728.17	-1549.78	2840.7	J	0.09
	2838.4	166.05	13.89	-1728.12	-1549.83	2842.86	F	0.06
	2853.04	299.59	22.52	-1727.82	-1550.16	2857.5	J	0.11
	2855.32	287.43	35.95	-1727.78	-1550.21	2859.78	F	0.23
	2855.89	35.94	30.57	-1727.76	-1550.22	2860.34	Js	0.13
	2858.07	56.13	14.28	-1727.72	-1550.27	2862.52	J	0.09
	2860.92	75.14	8.13	-1727.66	-1550.33	2865.37	J	0.02
59	2869.68	237.03	15.31	-1727.48	-1550.53	2874.13	F	0.1
60	2879.51	80.51	34.66	-1727.28	-1550.75	2883.95	Js	0.13
	2893.92	75.35	23.79	-1726.98	-1551.07	2898.35	J	0.13
	2922.5	57.02	12.78	-1726.46	-1551.8	2926.92	J	0.17
	2924.27	62.58	12.85	-1726.43	-1551.84	2928.69	Jf	0.17
	2926.11	57.8	17.62	-1726.39	-1551.89	2930.53	J	0.14
	2931.62	63.83	9.84	-1726.29	-1552.04	2936.03	F	0.04
	2932.77	53.84	37.81	-1726.27	-1552.07	2937.19	J	0.06
	2934.55	59.8	30.53	-1726.24	-1552.11	2938.97	J	0.1
	2935.64	56.62	31.48	-1726.22	-1552.14	2940.05	J	0.03
69	2939.87	91.3	12.37	-1726.15	-1552.25	2944.28	J	0.04
70	2940.34	42.27	16.57	-1726.14	-1552.26	2944.75	Jf	0.1
	2943.61	52.56	15.09	-1726.08	-1552.35	2948.02	Jf	0.02
	2954.86	40.16	18.36	-1725.88	-1552.64	2959.26	Jf	0.12
	2958.96	166.88	72.69	-1725.8	-1552.75	2963.36	J	0.14
	2964.31	297.95	19.11	-1725.71	-1552.89	2968.71	J	0.14
	2964.34	236.26	0.33	-1725.71	-1552.89	2968.74	J	0.03
	2964.44	90.84	23.9	-1725.71	-1552.89	2968.84	J	0.13
	2965.23	276.99	30.92	-1725.69	-1552.91	2969.63	J	0.1
	2967.8	38.82	5.91	-1725.65	-1552.98	2972.19	J	0.02
79	2969.69	53.21	17.56	-1725.61	-1553.03	2974.09	J	0.13

TABLE V (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
80	2974.74	16.65	33.62	-1725.52	-1553.16	2979.13	J	0.21
	2975.07	111.8	20.79	-1725.52	-1553.17	2979.46	J	0.06
	2980.08	74.16	9.46	-1725.43	-1553.3	2984.47	J	0.01
	2980.38	100.19	9.25	-1725.42	-1553.31	2984.77	J _s	0.04
	2984.37	107.89	10.17	-1725.35	-1553.41	2988.76	J	0.02
	2987.17	295.64	2.78	-1725.3	-1553.49	2991.55	F	0.02
	2990.59	54.33	9.3	-1725.24	-1553.57	2994.98	F	0.03
	2992.18	16.19	21.55	-1725.21	-1553.62	2996.56	J	0.11
	2994.74	49.77	24.68	-1725.16	-1553.68	2999.12	J _f	0.18
89	2996.78	145.71	8.18	-1725.13	-1553.74	3001.16	J	0.00
90	2997.31	13.08	27.57	-1725.12	-1553.75	3001.69	J _f	0.2
	2999.05	261.36	25.89	-1725.09	-1553.8	3003.43	J	0.16
	3000.93	322.61	8.95	-1725.05	-1553.84	3005.3	C	0.02
	3001.73	321.36	9.9	-1725.04	-1553.87	3006.11	C	0.03
	3004.02	217.44	11.14	-1725	-1553.92	3008.39	C	0.01
	3005.12	52.4	26.67	-1724.98	-1553.95	3009.49	J _f	0.17
	3005.13	239.92	17.1	-1724.98	-1553.95	3009.51	J	0.07
	3006.62	54.24	19.39	-1724.95	-1553.99	3011	J	0.04
	3014.86	198.02	32.71	-1724.83	-1554.22	3019.23	J _f	0.21
99	3015.81	189.45	29.93	-1724.82	-1554.25	3020.18	J _f	0.14
100	3020.18	161.82	46.2	-1724.75	-1554.36	3024.55	C	0.29
	3021.3	323.74	13.95	-1724.73	-1554.39	3025.67	F	0.08
	3024.3	339.23	67.4	-1724.68	-1554.47	3028.67	J _f	0.24
	3025.34	264.2	56.92	-1724.67	-1554.5	3029.7	J _f	0.46
	3029.52	271.44	43.86	-1724.6	-1554.61	3033.89	J _f	0.12
	3031.59	70.85	24.83	-1724.57	-1554.67	3035.95	F	0.15
	3036.38	269.63	19.32	-1724.49	-1554.8	3040.74	F ₁	0.09
	3036.62	84	22.22	-1724.49	-1554.81	3040.98	F	0.06
	3040.21	63.48	12.56	-1724.43	-1554.9	3044.57	J	0.06
109	3043.33	230.16	10.02	-1724.38	-1554.99	3047.69	J	0.02
110	3047.54	278.09	8.79	-1724.31	-1555.1	3051.89	J	0.02
	3048.8	276.29	22.71	-1724.29	-1555.13	3053.16	F	0.11
	3052.21	247.55	38.4	-1724.24	-1555.22	3056.56	J _s	0.11
	3053.65	71.77	6.51	-1724.22	-1555.26	3058	J	0.02
	3054.08	104.46	14.32	-1724.21	-1555.27	3058.43	F	0.07
	3054.35	213.96	12.89	-1724.21	-1555.28	3058.7	J _s	0.02
	3054.8	217.39	0.09	-1724.09	-1555.25	3059.15	J	0.02
	3056.23	260.92	4.4	-1724.18	-1555.33	3060.58	J	0.01
	3060.37	140.69	5.9	-1724.11	-1555.44	3064.72	J	0.05
119	3061.47	269.29	3.84	-1724.09	-1555.47	3065.82	J	0.04

TABLE V (cont)

	Depth Downhole No. (ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
120	3063.5	43.35	15.17	-1724.06	-1555.53	3067.85	C	0.03
	3064.43	48.67	17.32	-1724.05	-1555.55	3068.78	C	0.04
	3065.41	23.83	5.45	-1724.03	-1555.58	3069.76	J	0.03
	3068.11	53.2	15.95	-1723.99	-1555.65	3072.46	C	0.01
	3069.57	4.08	4.91	-1723.96	-1555.69	3073.91	J	0.01
	3074.16	69.91	16.74	-1723.89	-1555.81	3078.5	J	0.04
	3076.53	239.73	7.4	-1723.85	-1555.88	3080.88	Jf	0.05
	3083.38	18.16	2.49	-1723.74	-1556.06	3087.72	Jf	0.03
	3084.3	256.84	3.58	-1723.73	-1556.09	3088.63	J	0.07
129	3092.58	249.03	30.22	-1723.6	-1556.31	3096.91	C	0.05
130	3093.89	247.61	18.44	-1723.58	-1556.35	3098.22	C	0.07
	3098.08	287.25	31.79	-1723.51	-1556.46	3102.41	Jf	0.08
	3100.92	244.46	2.39	-1723.47	-1556.53	3105.25	J	0.07
	3101.21	289	17.83	-1723.46	-1556.54	3105.54	J	0.01
	3101.83	293.15	3.49	-1723.45	-1556.56	3106.16	F	0.05
	3106.51	118.45	5.83	-1723.38	-1556.69	3110.84	J	0.1
	3109.89	65.4	5.66	-1723.35	-1556.78	3114.22	F	0.07
	3118.94	73.37	17.85	-1723.22	-1557.03	3123.26	Jf	0.08
	3134.73	3.12	62.64	-1723.01	-1557.46	3139.05	J	0.27
139	3136.87	71.01	12.88	-1722.98	-1557.52	3141.19	F	0.06
140	3141.06	110.2	6.93	-1722.93	-1557.63	3145.37	J	0.03
	3142.19	154.54	4.19	-1722.91	-1557.67	3146.5	J	0.02
	3142.52	52.93	10.81	-1722.91	-1557.67	3146.83	F	0.06
	3144.31	10.56	20	-1722.88	-1557.72	3148.62	J	0.07
	3146.69	239.7	32.25	-1722.85	-1557.79	3151	Js	0.11
	3147.67	33.07	17.7	-1722.84	-1557.82	3151.98	Js	0.05
	3150.51	151.16	5.51	-1722.8	-1557.89	3154.81	C	0.01
	3150.91	85.54	25.37	-1722.79	-1557.9	3155.22	F	0.1
	3152.25	149.05	9.05	-1722.77	-1557.94	3156.56	F	0.03
149	3158.27	0.73	15.67	-1722.69	-1558.11	3162.57	F	0.07
150	3158.34	314.45	16.98	-1722.69	-1558.11	3162.64	J	0.04
	3161.09	11.26	60.9	-1722.66	-1558.18	3165.39	Jf	0.22
	3162.38	59.55	31.99	-1722.64	-1558.22	3166.68	Jf	0.08
	3172.94	252.46	20.53	-1722.5	-1558.51	3177.23	Js	0.07
	3173.1	293.63	10.45	-1722.49	-1558.51	3177.39	Js	0.15
	3176.6	127.62	11.23	-1722.45	-1558.61	3180.89	J	0.04
	3178.53	347.66	23.7	-1722.42	-1558.66	3182.82	J	0.18
	3179.3	125.24	22.12	-1722.41	-1558.68	3183.59	J	0.13
	3185.34	289.77	23.62	-1722.33	-1558.85	3189.63	J	0.16
159	3185.56	129.12	14.69	-1722.32	-1558.85	3189.85	Js	0.04

TABLE V (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
160	3185.85	328.16	40.02	-1722.32	-1558.86	3190.14	Js	0.05
	3188.37	55.67	7.95	-1722.29	-1558.93	3192.66	Js	0.03
	3189.72	37.17	7.7	-1722.27	-1558.97	3194.01	Js	0.02
	3194.36	186.76	35.79	-1722.21	-1559.1	3198.65	Js	0.13
	3196.28	290.23	39.71	-1722.18	-1559.15	3200.56	Jf	0.11
	3214.38	106.85	66.28	-1722.01	-1559.58	3218.66	J	0.26
	3221.04	123.55	36.04	-1721.95	-1559.73	3225.31	J	0.07
	3222.43	274.58	49.4	-1721.94	-1559.77	3226.7	J	0.1
	3235.76	203.8	51.14	-1721.83	-1560.07	3240.03	J	0.15
169	3243.18	32.35	14.89	-1721.76	-1560.24	3247.44	J	0.06
170	3244.31	280.99	19.05	-1721.75	-1560.27	3248.57	J	0.02
	3247.91	334.87	54.72	-1721.72	-1560.35	3252.17	J	0.08
	3248.6	40.49	12.6	-1721.72	-1560.37	3252.87	F	0.02
	3253.37	300.23	23.76	-1721.68	-1560.48	3257.64	F	0.11
	3255.33	240.39	24.99	-1721.66	-1560.52	3259.59	F	0.12
	3258.54	250.55	15.98	-1721.63	-1560.6	3262.8	F	0.08
	3261.73	353.77	13.34	-1721.61	-1560.67	3265.99	J	0.01
	3262.65	258.74	20.71	-1721.6	-1560.69	3266.91	F	0.2
	3263.74	270.54	31.39	-1721.59	-1560.72	3268	F	0.16
179	3265.69	260.04	41.33	-1721.57	-1560.76	3269.95	F	0.04
180	3265.69	272.16	23.54	-1721.57	-1560.76	3269.95	Jf	0.09
	3270.61	32.9	12.16	-1721.53	-1560.87	3274.87	F	0.13
	3272.76	27.74	17.31	-1721.51	-1560.92	3277.02	J	0.06
	3273.71	29.15	18.08	-1721.5	-1560.95	3277.97	J	0.09
	3275.42	357.26	7.79	-1721.49	-1560.98	3279.68	J	0.05
	3279.47	15.82	10.02	-1721.45	-1561.08	3283.73	F	0.08
	3282	184.15	18.37	-1721.43	-1561.14	3286.26	J	0.06
	3286.08	28.8	15.66	-1721.4	-1561.23	3290.34	F	0.09
	3292.3	37.17	13.64	-1721.35	-1561.37	3296.55	F	0.13
189	3293.81	328.05	1.44	-1721.33	-1561.41	3298.06	J	0.02
190	3300.41	197.5	65.73	-1721.28	-1561.56	3304.66	J	0.54
	3303.65	267.8	23.72	-1721.25	-1561.63	3307.9	J	0.1
	3313.97	289.74	7.39	-1721.22	-1561.87	3318.22	J	0.04
	3317.03	50.27	7.81	-1721.21	-1561.94	3321.28	F	0.01
	3319.89	285.8	4.08	-1721.2	-1562.01	3324.14	C	0.00
	3320.04	302.12	10.96	-1721.2	-1562.01	3324.28	F	0.08
	3320.26	192.57	38.34	-1721.19	-1562.02	3324.5	J	0.16
	3322.83	334.82	16.36	-1721.18	-1562.08	3327.07	F	0.03
	3326.77	283.89	12.45	-1721.17	-1562.17	3331.02	F	0.03
199	3333.16	255.27	11.01	-1721.14	-1562.31	3337.4	J	0.16

TABLE V (cont)

	Depth Downhole No. (ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
200	3334.31	244.05	25.37	-1721.14	-1562.34	3338.56	F	0.22
	3338.76	45.48	8.29	-1721.12	-1562.44	3343	J	0.04
	3339.07	21.35	11.02	-1721.12	-1562.45	3343.32	J	0.08
	3341.25	49.5	18.68	-1721.11	-1562.5	3345.5	F	0.12
	3343.41	55	12.97	-1721.1	-1562.55	3347.65	F	0.1
	3344.32	51.02	18.44	-1721.09	-1562.57	3348.56	F	0.14
	3344.81	34.11	25.24	-1721.09	-1562.58	3349.05	F	0.05
	3347.22	39.43	4.17	-1721.08	-1562.64	3351.46	J	0.04
	3347.85	84.89	10.66	-1721.08	-1562.65	3352.09	J	0.05
209	3348.33	40.93	4.16	-1721.08	-1562.66	3352.57	J	0.04
210	3349.93	63.53	12.1	-1721.07	-1562.7	3354.17	F	0.04
	3352.68	57.95	16.14	-1721.06	-1562.76	3356.92	F	0.09
	3354.95	53.88	9.43	-1721.05	-1562.81	3359.19	F	0.06
	3359.58	19.49	6.32	-1721.03	-1562.92	3363.82	F	0.02
	3360.54	38.8	14.43	-1721.03	-1562.94	3364.78	F	0.02
	3361.04	25.44	6.53	-1721.02	-1562.95	3365.28	F	0.03
	3361.94	55.57	5.81	-1721.02	-1562.97	3366.18	J	0.06
	3362.08	27.3	21.48	-1721.02	-1562.98	3366.32	J	0.11
	3363.11	358.16	5.57	-1721.01	-1563	3367.35	J	0.01
219	3369.97	342.41	3.77	-1720.99	-1563.16	3374.21	C	0.04
220	3377.07	70.22	11.82	-1720.96	-1563.32	3381.31	Js	0.08
	3377.48	299.23	14.45	-1720.95	-1563.33	3381.71	F	0.03
	3381.87	198.39	16.23	-1720.94	-1563.43	3386.1	J	0.11
	3394.39	183.68	22.24	-1720.88	-1563.72	3398.63	J	0.04
	3394.57	107.25	10.95	-1720.88	-1563.73	3398.8	F	0.01
	3402.14	218.52	15.17	-1720.85	-1563.9	3406.37	Js	0.09
	3404.75	241.51	15.53	-1720.84	-1563.96	3408.97	J	0.05
	3413.18	319.32	8.93	-1720.85	-1564.16	3417.4	F	0.07
	3415.92	241.67	24.57	-1720.85	-1564.23	3420.14	J	0.12
229	3417.57	123.79	48.07	-1720.85	-1564.26	3421.8	J	0.07
230	3417.94	248.02	34.26	-1720.85	-1564.27	3422.16	J	0.06
	3418.24	93.32	17.25	-1720.85	-1564.28	3422.47	F	0.02
	3422.49	108.55	21.8	-1720.85	-1564.38	3426.71	J	0.07
	3426.04	208.55	8.39	-1720.84	-1564.46	3430.26	J	0.02
	3426.22	284.01	49.9	-1720.84	-1564.47	3430.44	J	0.17
	3428.71	108.02	22.34	-1720.84	-1564.53	3432.93	J	0.03
	3433.06	101.57	18.71	-1720.84	-1564.63	3437.28	J	0.11
	3434.5	59.93	3.58	-1720.84	-1564.66	3438.72	J	0.03
	3436.04	206.82	29.22	-1720.84	-1564.7	3440.26	Js	0.18
239	3439.41	230.45	46.87	-1720.84	-1564.78	3443.63	J	0.38

TABLE V (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
240	3441.17	246.96	30.45	-1720.84	-1564.82	3445.39	J	0.11
	3442.35	261.78	35.5	-1720.83	-1564.85	3446.57	J	0.07
	3444.81	285.36	23.07	-1720.83	-1564.91	3449.03	J	0.16
	3450.64	68.82	16.23	-1720.83	-1565.05	3454.85	F	0.05
	3458.62	73.33	25.46	-1720.82	-1565.23	3462.84	F	0.09
	3462.36	223.7	15.12	-1720.82	-1565.32	3466.57	J	0.04
	3463.12	134.32	21.48	-1720.82	-1565.34	3467.33	J	0.06
	3465.07	6.28	37.45	-1720.82	-1565.39	3469.28	F	0.06
	3471.05	24.54	16.99	-1720.82	-1565.53	3475.26	Js	0.06
249	3474.07	267.63	27.34	-1720.82	-1565.6	3478.28	F	0.09
250	3474.88	76.92	20.98	-1720.82	-1565.62	3479.09	J	0.03
	3476.58	66.2	20.43	-1720.81	-1565.66	3480.78	J	0.05
	3476.67	274.19	8.84	-1720.81	-1565.66	3480.88	F	0.02
	3477.15	303.37	13.6	-1720.81	-1565.67	3481.36	J	0.07
	3478.69	137.82	38.89	-1720.81	-1565.71	3482.9	J	0.16
	3479.12	242.94	14.47	-1720.81	-1565.72	3483.32	Js	0.02
	3479.91	292.29	51.13	-1720.81	-1565.74	3484.12	J	0.12
	3480.36	47.97	55.6	-1720.81	-1565.75	3484.57	F	0.22
	3486.16	313.24	11.96	-1720.81	-1565.88	3490.37	F	0.02
259	3489.46	11.74	22.99	-1720.81	-1565.96	3493.67	Js	0.03
260	3494.12	320.22	11.66	-1720.8	-1566.07	3498.32	F	0.07
	3495.66	313.93	13.78	-1720.8	-1566.11	3499.87	Js	0.08
	3496.98	322.64	11.45	-1720.8	-1566.14	3501.18	Js	0.13
	3498.06	173.17	2.76	-1720.8	-1566.16	3502.26	Js	0.03
	3500.04	249.25	13.28	-1720.8	-1566.21	3504.24	F	0.06
	3500.44	352.32	18.94	-1720.8	-1566.22	3504.64	J	0.12
	3506.66	229.23	11.5	-1720.8	-1566.37	3510.86	F	0.06
	3516.05	301.63	5.25	-1720.78	-1566.61	3520.25	J	0.09
	3516.83	52.76	15.65	-1720.78	-1566.63	3521.03	Js	0.06
269	3520.65	175.89	16.59	-1720.78	-1566.72	3524.85	Js	0.1
270	3522.14	31.61	6.22	-1720.77	-1566.76	3526.33	Js	0.07
	3524.64	208.06	24.37	-1720.77	-1566.82	3528.83	J	0.08
	3526.12	54.68	21.3	-1720.77	-1566.86	3530.31	Js	0.08
	3532.22	152.12	51.87	-1720.76	-1567.01	3536.41	F	0.23
	3536.54	345.88	3.81	-1720.76	-1567.11	3540.72	J	0.06
	3539.65	326.94	15.82	-1720.75	-1567.19	3543.83	J	0.07
	3543.9	285.8	3.86	-1720.75	-1567.29	3548.08	J	0.03
	3545.8	52.25	6.57	-1720.75	-1567.34	3549.98	J	0.05
	3548.44	310.97	24.71	-1720.74	-1567.41	3552.62	J	0.13
279	3549.25	269.13	27.03	-1720.74	-1567.43	3553.43	J	0.16

TABLE V (cont)

	Depth Downhole No. (ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
280	3551.76	204.51	29.67	-1720.74	-1567.49	3555.94	F	0.23
	3555.71	321.83	9.5	-1720.74	-1567.59	3559.89	Js	0.09
	3556.08	160.15	10.99	-1720.74	-1567.6	3560.26	J	0.06
	3558.51	348.08	15.49	-1720.73	-1567.66	3562.69	F	0.02
	3561.18	21.96	15.53	-1720.73	-1567.72	3565.35	F	0.12
	3577.68	351.26	8.82	-1720.71	-1568.13	3581.85	Js	0.05
	3577.74	255.91	28.72	-1720.71	-1568.13	3581.91	J	0.05
	3588.99	94.91	7.93	-1720.7	-1568.41	3593.16	J	0.09
	3589.53	142.82	24.79	-1720.7	-1568.42	3593.7	J	0.23
289	3596.19	4.39	9.32	-1720.69	-1568.59	3600.35	J	0.08
290	3598.43	21.06	13.7	-1720.69	-1568.64	3602.59	J	0.05
	3604.55	27.9	26.7	-1720.68	-1568.79	3608.71	J	0.09
	3608.48	168.68	27.18	-1720.68	-1568.89	3612.64	J	0.08
	3611.36	41.38	28.26	-1720.62	-1568.96	3615.52	J	0.1
	3614.55	225.14	14.32	-1720.6	-1569.04	3618.71	F	0.1
	3616.01	344.23	20	-1720.6	-1569.07	3620.16	Js	0.09
	3619.14	279.63	12.56	-1720.58	-1569.15	3623.3	F	0.12
	3624.34	291.91	8.54	-1720.55	-1569.28	3628.5	F	0.11
	3627.65	89.43	67.3	-1720.53	-1569.36	3631.8	C	0.1
299	3629.95	56.35	17.94	-1720.52	-1569.41	3634.1	F	0.2
300	3630.33	275.79	18.33	-1720.52	-1569.42	3634.48	J	0.11
	3634.96	265.97	53.07	-1720.49	-1569.54	3639.11	J	0.15
	3637.3	287.5	29.29	-1720.48	-1569.59	3641.46	Js	0.14
	3644.37	172.59	12.43	-1720.44	-1569.77	3648.52	F	0.07
	3644.99	359.03	25.31	-1720.44	-1569.78	3649.14	J	0.12
	3655.87	333.81	19.15	-1720.37	-1570.05	3660.02	J	0.06
	3661.71	44.29	6.79	-1720.34	-1570.19	3665.86	F	0.03
	3663.66	42.06	42.36	-1720.33	-1570.24	3667.81	J	0.16
	3663.84	279.21	27.87	-1720.33	-1570.24	3667.98	J	0.11
309	3669.06	9.58	16.96	-1720.3	-1570.37	3673.2	J	0.1
310	3669.06	200.01	26.8	-1720.3	-1570.37	3673.21	J	0.09
	3669.87	128.82	16.75	-1720.3	-1570.39	3674.02	J	0.02
	3682.6	36.83	23.51	-1720.23	-1570.7	3686.74	F	0.18
	3683.06	34.79	23.69	-1720.22	-1570.71	3687.19	F	0.19
	3684.09	16.95	6.1	-1720.22	-1570.74	3688.23	J	0.08
	3692.23	48.21	14.81	-1720.17	-1570.94	3696.36	F	0.03
	3693.33	44.63	13.97	-1720.17	-1570.97	3697.46	F	0.11
	3694.49	42.69	17.74	-1720.16	-1570.99	3698.62	F	0.03
	3694.63	44.81	3.91	-1720.16	-1571	3698.76	J	0.03
319	3694.67	43.92	15.2	-1720.16	-1571	3698.8	F	0.06

TABLE V (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
320	3699.25	66.67	23.91	-1720.13	-1571.11	3703.38	F	0.08
	3702.08	270.02	5.83	-1720.12	-1571.18	3706.21	J	0.03
	3714.29	59.92	26.13	-1720	-1571.54	3718.41	F	0.04
	3715.79	70.6	24.41	-1719.99	-1571.58	3719.91	F	0.11
	3727.3	42.51	5.91	-1719.88	-1571.92	3731.42	J	0.04
	3733.84	64.43	24.33	-1719.82	-1572.1	3737.96	J	0.17
	3739.06	260.16	38.7	-1719.77	-1572.26	3743.18	J	0.2
	3741.68	32.43	17.68	-1719.75	-1572.33	3745.79	F	0.13
	3746.01	40.67	31.14	-1719.71	-1572.46	3750.12	F	0.25
329	3754	224.56	14.2	-1719.64	-1572.69	3758.11	J	0.12
330	3757.61	224.76	16.01	-1719.61	-1572.79	3761.72	J	0.13
	3758.01	212.96	2.24	-1719.6	-1572.8	3762.12	J	0.03
	3764.83	232.92	64.01	-1719.54	-1573	3768.93	J	0.42
	3765.72	211.87	7.02	-1719.53	-1573.02	3769.83	J	0.07
	3768.9	195.81	8.48	-1719.5	-1573.11	3773	J	0.02
	3773.52	46.33	9.76	-1719.46	-1573.25	3777.62	J	0.07
	3774.61	236.65	9.69	-1719.45	-1573.28	3778.71	J	0.05
	3774.65	72.33	37.92	-1719.45	-1573.28	3778.75	J	0.15
	3781.74	74.07	11.1	-1719.39	-1573.48	3785.84	J	0.14
339	3787.18	300.99	54.67	-1719.34	-1573.64	3791.27	F	0.56
340	3792.49	91.48	11.71	-1719.29	-1573.79	3796.59	F	0.06
	3796.69	31.71	41.79	-1719.25	-1573.91	3800.78	F	0.13
	3798.17	79.33	43.02	-1719.24	-1573.96	3802.26	F	0.2
	3798.52	113.01	13.72	-1719.23	-1573.97	3802.62	Js	0.03
	3806.95	30.3	22.78	-1719.16	-1574.21	3811.04	Js	0.14
	3813.19	142.02	9.15	-1719.09	-1574.44	3817.27	C	0.07
	3813.53	80.31	13.67	-1719.09	-1574.45	3817.61	F	0.08
	3813.71	147.83	74.37	-1719.09	-1574.46	3817.8	F	0.49
	3817.34	166.65	29.64	-1719.06	-1574.58	3821.42	Js	0.06
349	3818.63	253.25	25.43	-1719.04	-1574.62	3822.71	Js	0.31
350	3818.75	65.36	15.18	-1719.04	-1574.62	3822.83	F	0.08
	3822.51	156.04	16.09	-1719.01	-1574.74	3826.59	F	0.16
	3822.6	326.79	1.79	-1719.01	-1574.75	3826.68	Js	0.05
	3827.93	147.73	41.56	-1718.95	-1574.92	3832	Js	0.39
	3831.96	211.96	25.22	-1718.92	-1575.05	3836.03	Js	0.11
	3841.95	157.9	81.47	-1718.82	-1575.38	3846.01	Js	0.74
	3843.99	105.65	12.38	-1718.8	-1575.44	3848.05	F	0.08
	3844.42	356.6	1.85	-1718.8	-1575.46	3848.48	Js	0.01
	3845.75	222.08	7.03	-1718.79	-1575.5	3849.82	J	0.03
359	3852.05	179.12	55.17	-1718.73	-1575.71	3856.11	Js	0.11

TABLE V (cont)

	Depth Downhole No. (ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
360	3853.53	228.29	69.99	-1718.71	-1575.75	3857.58	Js	0.49
	3856.36	62.29	27.36	-1718.68	-1575.85	3860.42	Js	0.17
	3858.33	47.08	50.6	-1718.67	-1575.91	3862.38	J	0.12
	3859.95	313.22	27.68	-1718.65	-1575.96	3864.01	J	0.03
	3864.7	285.48	68.2	-1718.61	-1576.12	3868.76	J	0.22
	3867.78	124.42	10.72	-1718.58	-1576.22	3871.83	C	0.02
	3867.82	216.32	35.36	-1718.58	-1576.22	3871.87	C	0.18
	3868.3	240.27	70.35	-1718.57	-1576.24	3872.35	F	2.23
	3872.38	137.06	62.64	-1718.53	-1576.37	3876.43	F	0.1
369	3876.38	348.74	5.85	-1718.49	-1576.5	3880.42	F	0.02
370	3877.53	40.07	43.3	-1718.48	-1576.54	3881.57	F	0.15
	3879.18	163.3	22.62	-1718.47	-1576.59	3883.22	J	0.03
	3884.71	12.21	20.66	-1718.42	-1576.77	3888.75	J	0.04
	3886.1	240.43	14.57	-1718.4	-1576.82	3890.14	F	0.04
	3890.45	203.59	11.69	-1718.36	-1576.96	3894.48	J	0.01
	3892.96	33.63	6.37	-1718.34	-1577.04	3896.99	Js	0.02
	3893.82	297.68	15.92	-1718.33	-1577.07	3897.86	Js	0.04
	3896.36	46.79	12.97	-1718.3	-1577.15	3900.39	Js	0.02
	3896.76	173.73	18.19	-1718.3	-1577.16	3900.8	C	0.03
379	3902.37	191.23	2.3	-1718.25	-1577.35	3906.4	Js	0.09
380	3905.27	225.45	31.75	-1718.22	-1577.44	3909.29	J	0.19
	3907.38	42.29	3.38	-1718.2	-1577.53	3911.41	C	0.03
	3911.75	185.98	7.2	-1718.16	-1577.69	3915.78	J	0.03
	3914.11	32.89	18.7	-1718.13	-1577.78	3918.13	J	0.19
	3915.09	261.59	49.01	-1718.12	-1577.81	3919.11	J	0.17
	3922.48	134.41	19.6	-1718.05	-1578.07	3926.5	F	0.13
	3925.43	223.12	26.95	-1718.02	-1578.18	3929.44	F	0.14
	3928.27	228.87	16.91	-1718	-1578.28	3932.28	J	0.14
	3932.09	214.38	19.77	-1717.96	-1578.42	3936.1	F	0.16
389	3933.69	217.39	17.92	-1717.94	-1578.48	3937.69	F	0.21
390	3934.36	56.03	29.97	-1717.94	-1578.5	3938.37	J	0.12
	3936.08	236.41	40.41	-1717.92	-1578.56	3940.09	F	0.08
	3938.76	1.62	40.6	-1717.89	-1578.66	3942.76	J	0.14
	3941.76	230.8	16.89	-1717.86	-1578.76	3945.76	F	0.09
	3942.65	3.98	40.73	-1717.86	-1578.8	3946.65	J	0.19
	3942.79	16.37	10.26	-1717.85	-1578.8	3946.79	J	0.01
	3944.95	39.89	16.13	-1717.83	-1578.88	3948.95	J	0.02
	3947.2	53.27	16.59	-1717.81	-1578.96	3951.2	J	0.03
	3947.69	159.23	12.54	-1717.81	-1578.98	3951.68	J	0.03
399	3949.33	339.32	15.3	-1717.79	-1579.04	3953.33	J	0.04

TABLE V (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
400	3952.26	176.76	79.41	-1717.76	-1579.14	3956.25	J	1.52
	3955.28	326.84	40.86	-1717.73	-1579.25	3959.27	J	0.2
	3957.47	214.56	5.72	-1717.71	-1579.33	3961.46	F	0.11
	3957.63	12.56	1.66	-1717.71	-1579.33	3961.62	J	0.04
	3959.12	8	49.54	-1717.7	-1579.39	3963.11	J	0.13
	3961.65	202.76	20.34	-1717.67	-1579.48	3965.63	F	0.16
	3965.04	344.06	68.38	-1717.64	-1579.6	3969.03	J	0.59
	3968.13	22.35	14.51	-1717.61	-1579.71	3972.11	J	0.03
	3972.31	336.72	26.41	-1717.57	-1579.86	3976.29	J	0.21
409	3973.52	317.19	18.68	-1717.56	-1579.9	3977.5	J	0.12
410	3973.9	46.95	24.56	-1717.55	-1579.92	3977.88	F	0.14
	3974.87	191.13	6.87	-1717.54	-1579.95	3978.85	Js	0.11
	3977.5	47.63	14.42	-1717.52	-1580.04	3981.47	F	0.05
	3978.12	42.78	13.71	-1717.51	-1580.07	3982.1	F	0.05
	3978.72	43.33	4.52	-1717.51	-1580.09	3982.69	Js	0.08
	3982.33	46.74	15.45	-1717.47	-1580.22	3986.3	F	0.1
	3983	174.59	9.08	-1717.46	-1580.24	3986.97	C	0.1
	3984.98	47.88	9.97	-1717.45	-1580.31	3988.95	F	0.08
	3986.55	208.16	1.15	-1717.43	-1580.37	3990.51	J	0.06
419	3988.97	201.67	28.65	-1717.41	-1580.45	3992.93	F	0.12
420	3990.29	213.95	6.55	-1717.39	-1580.5	3994.26	J	0.1
	3992.21	144.61	8.57	-1717.38	-1580.57	3996.18	J	0.03
	3992.63	86.58	12.2	-1717.37	-1580.59	3996.6	F	0.03
	3993.39	155.91	67.17	-1717.36	-1580.61	3997.36	J	0.23
	3993.57	348.88	14.55	-1717.36	-1580.62	3997.53	Js	0.03
	3994.2	108.11	19.26	-1717.36	-1580.64	3998.16	F	0.13
	3996.14	41.1	19.02	-1717.34	-1580.71	4000.1	Js	0.03
	3999.69	295.05	34.99	-1717.3	-1580.84	4003.65	Js	0.03
	4000.29	248.41	49.62	-1717.3	-1580.86	4004.25	Js	0.07
429	4000.32	97.26	6.75	-1717.3	-1580.86	4004.28	Js	0.05
430	4001.79	118.1	16.93	-1717.28	-1580.91	4005.75	Js	0.11
	4002.12	24.34	13.57	-1717.28	-1580.93	4006.08	Js	0.08
	4004.31	100.16	18.27	-1717.26	-1581	4008.26	F	0.12
	4004.42	171.07	5.28	-1717.26	-1581.01	4008.38	Js	0.04
	4005.33	103.68	19.97	-1717.25	-1581.04	4009.28	Js	0.05
	4007.64	96.07	14.82	-1717.23	-1581.12	4011.6	F	0.15
	4007.86	167.87	9.99	-1717.22	-1581.13	4011.81	F	0.13
	4013.16	32.89	18.6	-1717.17	-1581.34	4017.11	Js	0.09
	4015.07	217.91	26.77	-1717.15	-1581.41	4019.02	Js	0.18
439	4017.12	61.93	53.78	-1717.13	-1581.48	4021.07	Js	0.25

TABLE V (cont)

	Depth Downhole No. (ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
440	4017.74	52.82	34.65	-1717.12	-1581.51	4021.69	Js	0.18
	4018.5	46.89	29.43	-1717.12	-1581.53	4022.44	Js	0.23
	4019.09	59.49	28.23	-1717.11	-1581.56	4023.03	Js	0.37
	4020.68	16.46	9.83	-1717.09	-1581.62	4024.63	Js	0.08
	4021.74	137.52	71.85	-1717.08	-1581.65	4025.68	Js	0.26
	4025.39	301.26	31.85	-1717.05	-1581.79	4029.33	Js	0.14
	4030.76	308.44	11.91	-1716.99	-1581.99	4034.7	Js	0.08
	4030.83	207.19	31.73	-1716.99	-1581.99	4034.77	Js	0.11
	4031.86	208.34	40.36	-1716.98	-1582.03	4035.8	Js	0.16
449	4031.86	43.74	14.12	-1716.98	-1582.03	4035.8	F	0.06
450	4039.83	78.05	15.62	-1716.9	-1582.32	4043.76	F	0.1
	4044.01	27.6	5.93	-1716.86	-1582.48	4047.94	Js	0.09
	4044.35	91.91	15.99	-1716.86	-1582.49	4048.28	F	0.04
	4045.42	95.67	36.26	-1716.85	-1582.53	4049.35	Js	0.09
	4056.03	57.59	26.93	-1716.74	-1582.92	4059.95	J	0.17
	4056.61	206.63	14.74	-1716.73	-1582.94	4060.53	J	0.1
	4057.72	340.71	6.94	-1716.72	-1582.99	4061.64	F	0.03
	4060.62	309.86	8.98	-1716.69	-1583.09	4064.54	F	0.07
	4061.87	311.04	8.76	-1716.68	-1583.14	4065.79	F	0.1
459	4066.38	318.47	16.57	-1716.64	-1583.31	4070.3	F	0.13
460	4066.79	217.38	17.98	-1716.63	-1583.32	4070.7	J	0.11
	4069.37	78.52	45.69	-1716.61	-1583.42	4073.28	J	0.11
	4072.02	220.14	27.12	-1716.58	-1583.51	4075.93	J	0.05
	4075.78	287.18	5.93	-1716.54	-1583.65	4079.68	F	0.01
	4076.57	287.34	45.88	-1716.53	-1583.68	4080.47	J	0.04
	4080.36	86.08	6.69	-1716.5	-1583.82	4084.26	J	0.01
	4082.95	249.25	11.22	-1716.47	-1583.92	4086.85	J	0.05
	4093.36	196.25	21.71	-1716.37	-1584.3	4097.26	C	0.04
	4093.46	272.6	6.2	-1716.37	-1584.31	4097.36	J	0.07
469	4095.62	99.14	11.86	-1716.34	-1584.39	4099.51	C	0.01
470	4096.31	241.72	7.28	-1716.34	-1584.41	4100.21	F	0.02
	4097.03	244.16	7.98	-1716.33	-1584.44	4100.93	F	0.02
	4097.62	316.98	15.31	-1716.32	-1584.46	4101.51	J	0.03
	4098.8	258.56	10.9	-1716.31	-1584.51	4102.69	F	0.01
	4098.99	48.45	5.93	-1716.31	-1584.51	4102.88	J	0.02
	4099.79	254.1	11.13	-1716.3	-1584.54	4103.68	F	0.02
	4101.26	250.64	14.28	-1716.29	-1584.6	4105.15	F	0.03
	4103.56	111.24	12.12	-1716.26	-1584.68	4107.44	C	0.01
	4105.8	90.2	22.89	-1716.24	-1584.76	4109.69	J	0.19
479	4111.47	277.83	3.28	-1716.15	-1585.01	4115.35	J	0.05

TABLE V (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
480	4113.36	280.64	12.57	-1716.12	-1585.08	4117.24	J	0.08
	4119.68	82.69	43.48	-1716.04	-1585.34	4123.55	J	0.15
	4125.89	94.75	19.01	-1715.96	-1585.59	4129.76	J	0.09
	4126.82	161.73	5.38	-1715.94	-1585.62	4130.69	J	0.07
	4133.26	119.98	11.04	-1715.86	-1585.88	4137.12	J	0.09
	4137.53	78.06	13.88	-1715.8	-1586.05	4141.38	J _s	0.09
	4141.47	194.29	15.23	-1715.75	-1586.21	4145.32	J	0.09
	4143.15	112.3	67.81	-1715.73	-1586.28	4147	J	0.47
	4145.71	198.56	75.05	-1715.69	-1586.38	4149.56	J	0.14
489	4150.77	101.46	18.73	-1715.63	-1586.58	4154.62	J	0.11
490	4163.53	234.31	20.09	-1715.46	-1587.09	4167.36	F	0.08
	4165.36	230.33	14.85	-1715.43	-1587.16	4169.19	F	0.03
	4169.26	193.31	17.54	-1715.38	-1587.32	4173.08	F1	0.09
	4174.11	85.24	49.51	-1715.32	-1587.51	4177.94	J	0.13
	4176.72	175.31	14.52	-1715.28	-1587.62	4180.54	F	0.04
	4177.14	274.62	10.64	-1715.28	-1587.64	4180.96	C	0.07
	4191.14	7.51	31.77	-1715.09	-1588.2	4194.94	C	0.17
	4194.13	353.43	73.59	-1715.05	-1588.32	4197.93	J	0.6
	4196.81	77.07	41.63	-1715.02	-1588.42	4200.62	F	0.13
499	4201.41	98.04	35.9	-1714.96	-1588.61	4205.21	F?	0.1
500	4204.22	110.68	22.38	-1714.92	-1588.72	4208.02	F	0.17
	4207.96	245.1	27.99	-1714.87	-1588.87	4211.75	J	0.09
	4211.14	101.6	41.63	-1714.83	-1589	4214.93	F	0.19
	4211.99	107.61	34.27	-1714.82	-1589.03	4215.78	F1	0.09
	4215.91	87.02	40.67	-1714.76	-1589.19	4219.7	F1	0.18
	4218.72	82.33	31.87	-1714.73	-1589.3	4222.51	F	0.11
	4218.98	33.3	19.87	-1714.72	-1589.31	4222.76	J	0.02
	4220.8	227.28	22.52	-1714.7	-1589.38	4224.58	J	0.08
	4223.38	102.79	49.47	-1714.67	-1589.49	4227.15	F1	0.22
509	4231.45	119.02	26.25	-1714.56	-1589.81	4235.23	F1	0.11
510	4231.88	122.43	26.89	-1714.55	-1589.83	4235.66	F1	0.11
	4237.38	309.37	25.7	-1714.48	-1590.05	4241.15	J	0.06
	4244.94	168.54	79.67	-1714.38	-1590.35	4248.7	J	0.54
	4256.3	203.41	15.63	-1714.23	-1590.8	4260.05	J	0.1
	4258.59	260.08	17.65	-1714.2	-1590.89	4262.34	F	0.14
	4259.77	268.32	14.96	-1714.18	-1590.94	4263.52	F	0.12
	4265.08	288.92	31.53	-1714.11	-1591.15	4268.83	J	0.28
517	4267.87	168.93	87.13	-1714.08	-1591.26	4271.6	F1	0.87

NB: Entry no.116:interpolation inaccuracy from 2990 feet 298:inclination
omission:estimate 67.30 degrees.

TABLE VI: LOCATION AND ORIENTATION OF STRUCTURES IN TELEVIEWER RUN 2,
FROM 4000 TO 4565 ft^a

Depth Downhole No. (ft)	Orientation		Location			Type	Fit (ft)
	Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
1 4000.97	48.27	12.56	-1717.29	-1580.89	4004.93	Js	0.08
4001.91	211.42	39.09	-1717.28	-1580.92	4005.87	F?	0.19
4002.61	220.27	28.9	-1717.27	-1580.95	4006.57	F?	0.17
4005.19	27.08	9.86	-1717.25	-1581.04	4009.15	Js	0.11
4005.23	168.88	5.63	-1717.25	-1581.04	4009.18	Js	0.06
4005.64	210.17	29.1	-1717.24	-1581.06	4009.6	F?	0.16
4008.13	34.6	12.88	-1717.22	-1581.15	4012.08	Js	0.03
4013.92	142.58	14.99	-1717.16	-1581.36	4017.87	F?	0.1
9 4014.64	139.23	59.94	-1717.15	-1581.39	4016.59	J?	0.43
10 4017.91	141.21	24.29	-1717.12	-1581.51	4021.86	F?	0.17
4021.26	81.05	72.62	-1717.09	-1581.64	4025.2	J?	0.54
4025.97	347.09	3.92	-1717.04	-1581.81	4029.91	J	0.07
4031.38	14.28	3.49	-1716.99	-1582.01	4035.32	J	0.06
4035.31	175.11	6.49	-1716.95	-1582.16	4039.25	J	0.03
4052.46	226.54	3.36	-1716.78	-1582.79	4056.39	J?	0.06
4053.64	113.08	19.71	-1717.76	-1582.83	4057.57	F?	0.07
4055.05	55.47	4.12	-1716.75	-1582.89	4058.98	J	0.02
4057.38	89.7	15.29	-1716.73	-1582.97	4061.3	F?	0.05
19 4069.42	123.07	6.95	-1716.61	-1583.42	4073.33	J	0.05
20 4070.7	11	18.6	-1716.59	-1583.47	4074.61	F?	0.11
4080.49	228.68	6.1	-1716.5	-1583.83	4084.39	J	0.02
4083.36	239.26	7.23	-1716.47	-1583.93	4087.26	Js	0.04
4087.7	113.65	21.62	-1716.42	-1584.09	4091.6	Js	0.02
4088.02	61.63	18.91	-1716.42	-1584.11	4091.92	Js	0.04
4093	50.68	10.75	-1716.37	-1584.29	4096.9	F?	0.03
4093.72	260.45	8.58	-1716.36	-1584.32	4097.61	Js	0.04
4102.08	355.2	19.5	-1716.27	-1584.63	4105.97	Js	0.05
4109.4	79.37	19.63	-1716.18	-1584.93	4113.28	J	0.01
29 4114.68	122.73	11.25	-1716.11	-1585.14	4118.56	J	0.03
30 4114.8	85.71	21.87	-1716.1	-1585.14	4118.68	J	0.09
4116.21	278.16	4.42	-1716.09	-1585.2	4120.09	Js	0.04
4117.03	289.29	13.64	-1716.07	-1585.23	4120.9	J	0.02
4124.04	173.51	7.38	-1715.98	-1585.51	4127.9	Js	0.05
4124.73	93.08	26.7	-1715.97	-1585.54	4128.6	F	0.06
4125.76	230.82	17.58	-1715.96	-1585.58	4129.63	J	0.09
4128.99	69.27	27.74	-1715.92	-1585.71	4132.86	F	0.07
4131.59	129.59	22.86	-1715.88	-1585.81	4135.46	F	0.04
4133.4	113.52	59.76	-1715.86	-1585.89	4137.26	F	0.08
39 4135.08	81.78	26.62	-1715.84	-1585.95	4138.94	F	0.04

^aOrientations refer to pole to plane. Azimuths are degrees east of true north. Inclination is positive down (degrees below the horizon). Fit is root-mean-square error in fit of Equation 1.

TABLE VI (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
40	4135.88	84.62	41.92	-1715.82	-1585.99	4139.74	F	0.05
	4138.64	18.83	61.18	-1715.79	-1586.1	4142.5	F	0.17
	4143.44	140.82	47.07	-1715.72	-1586.29	4147.29	F	0.14
	4147.49	198.36	69.9	-1715.67	-1586.45	4151.33	F	0.16
	4150.28	118.56	56.23	-1715.63	-1586.56	4154.12	F	0.17
	4151.25	244.07	1.27	-1715.62	-1586.6	4155.09	J	0.01
	4153.76	166.10	64.46	-1715.59	-1586.7	4157.61	F	0.11
	4155.46	189.43	57.35	-1715.57	-1586.77	4159.3	F	0.20
	4157.07	162.57	59.39	-1715.54	-1586.83	4160.91	F	0.12
49	4165.69	296.23	21.42	-1715.43	-1587.18	4169.52	Js	0.04
50	4167.08	275.95	10.54	-1715.41	-1587.23	4170.91	Js	0.14
	4173.25	75.66	67.87	-1715.33	-1587.48	4177.07	F?	0.1
	4181.96	132.11	27.72	-1715.21	-1587.83	4185.77	Fs	0.1
	4182.24	75.21	13.81	-1715.21	-1587.84	4186.06	J	0.05
	4184.2	110.69	40.63	-1715.18	-1587.92	4188.01	Fs	0.13
	4184.97	233.97	24.43	-1715.17	-1587.95	4188.78	J	0.10
	4186.65	66.9	48.14	-1715.15	-1588.02	4190.47	Fs	0.14
	4189.26	233.78	72.51	-1715.12	-1588.12	4193.07	Fs	0.34
	4189.35	44.32	19.67	-1715.12	-1588.12	4193.16	C?	0.01
59	4190.64	67.83	22.13	-1715.1	-1588.18	4194.45	C?	0.05
60	4192.5	100.54	19.53	-1715.07	-1588.25	4196.31	C?	0.02
	4192.72	291.44	6.49	-1715.07	-1588.26	4196.53	J	0.04
	4195.09	91	15.57	-1715.04	-1588.35	4198.9	C?	0.02
	4195.5	289.36	10.57	-1715.03	-1588.37	4199.3	J	0.13
	4198.18	359.74	67.23	-1715	-1588.48	4201.98	F?	0.14
	4200.86	99.62	28.04	-1714.96	-1588.58	4204.65	Js	0.17
	4202.73	8.38	7.89	-1714.94	-1588.66	4206.53	J	0.02
	4202.92	198.98	27.06	-1714.94	-1588.67	4206.71	J?	0.07
	4203.19	79.33	30.50	-1714.93	-1588.68	4206.99	J	0.02
69	4204.82	222.81	18.71	-1714.91	-1588.74	4208.61	J?	0.04
70	4207.61	301.69	10.24	-1714.87	-1588.85	4211.41	J	0.01
	4207.68	219.89	14.56	-1714.87	-1588.86	4211.47	J?	0.03
	4207.97	189.25	14.99	-1714.87	-1588.87	4211.76	J?	0.01
	4211.28	100.61	30.48	-1714.83	-1589	4215.07	F1	0.11
	4227.88	147.7	49.07	-1714.61	-1589.67	4231.66	F1	0.06
	4229.94	168.98	35.83	-1714.56	-1589.75	4233.72	F1	0.12
	4231.24	141.72	35.32	-1714.56	-1589.8	4235.01	F1	0.16
	4239.57	185.4	3.14	-1714.45	-1590.13	4243.33	J	0.02
	4243.07	218.04	44.5	-1714.4	-1590.27	4246.83	F?	0.23
79	4245.95	71.42	7.47	-1714.37	-1590.39	4249.71	J	0.04

TABLE VI (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
80	4245.98	175.33	74.81	-1714.37	-1590.39	4249.73	F?	0.76
	4250.87	119.18	8.61	-1714.3	-1590.58	4254.62	J?	0.03
	4251.47	64.78	9.49	-1714.29	-1590.61	4255.23	J	0.02
	4251.62	213.52	1.63	-1714.29	-1590.61	4255.37	J _s	0.06
	4251.88	300.38	29.57	-1714.29	-1590.63	4255.63	J	0.03
	4252.54	222.29	21.61	-1714.28	-1590.65	4256.3	J	0.02
	4252.98	259.33	18.01	-1714.27	-1590.67	4256.73	J	0.14
	4252.99	74.78	11.66	-1714.27	-1590.67	4256.75	J	0.07
	4253.02	313.1	4.58	-1714.27	-1590.67	4256.77	J	0.05
89	4254.97	285.06	54.27	-1714.25	-1590.75	4258.72	F?	0.12
90	4257.39	171.38	37.67	-1714.21	-1590.85	4261.13	J	0.06
	4258.2	280.9	84.52	-1714.2	-1590.88	4261.95	F?	1.79
	4260.23	257.98	11.08	-1714.18	-1590.96	4263.96	F	0.02
	4262.01	234.35	33.82	-1714.15	-1591.03	4265.75	F	0.16
	4264.7	270.74	8.75	-1714.12	-1591.14	4268.45	J	0.02
	4264.81	231.9	31.55	-1714.12	-1591.14	4268.56	F	0.1
	4267.55	275.26	15.46	-1714.08	-1591.25	4271.29	F	0.1
	4268.38	322.55	3.28	-1714.07	-1591.29	4272.11	J _s	0.05
	4271.41	191.1	30.7	-1714.03	-1591.41	4275.15	F	0.2
99	4274.98	164.63	64.98	-1713.98	-1591.55	4278.72	F	0.34
100	4277.98	65.4	14.04	-1713.94	-1591.67	4281.71	J	0.12
	4278.25	176.23	8.51	-1713.94	-1591.68	4281.98	J	0.03
	4282.37	201.23	40.76	-1713.88	-1591.84	4286.1	F	0.27
	4283.53	174.37	69.25	-1713.87	-1591.89	4287.26	F	0.22
	4283.98	82.58	11.57	-1713.86	-1591.91	4287.7	J	0.06
	4285.33	197.35	28.85	-1713.84	-1591.96	4289.06	J _s	0.08
	4285.62	77.97	10.23	-1713.84	-1591.97	4289.35	J	0.05
	4285.74	32.66	47.38	-1713.84	-1591.98	4289.46	F	0.11
	4286.98	211.38	23.37	-1713.82	-1592.03	4290.7	J	0.1
109	4287.5	72.88	18.8	-1713.82	-1592.05	4291.22	F	0.05
110	4287.92	63.84	10.45	-1713.81	-1592.07	4291.64	J	0.07
	4290.4	72.95	14.48	-1713.78	-1592.17	4294.12	F	0.08
	4293.4	56.94	17	-1713.74	-1592.29	4297.12	F	0.08
	4296.1	41.97	36.55	-1713.7	-1592.39	4299.81	F	0.13
	4298.08	74.2	54.05	-1713.68	-1592.47	4301.79	F	0.05
	4301.44	253.36	51.65	-1713.63	-1592.61	4305.15	F	0.16
	4303.89	155.34	24.56	-1713.59	-1592.7	4307.59	J?	0.07
	4304.46	187.54	37.46	-1713.59	-1592.73	4308.16	J?	0.05
	4304.98	290.71	15.14	-1713.58	-1592.75	4308.68	F?	0.11
119	4308.09	291.07	17.35	-1713.53	-1592.87	4311.79	F	0.13

TABLE VI (cont)

Depth Downhole No.	Orientation		Location			Type	Fit (ft)	
	Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)			
120	4310.54	271.78	22.12	-1713.5	-1592.96	4314.24	F	0.12
	4314.59	267.13	30.32	-1713.44	-1593.12	4318.28	F	0.08
	4317.57	5.74	11.92	-1713.4	-1593.24	4321.27	J	0.12
	4317.79	159.32	5.06	-1713.39	-1593.25	4321.48	J	0.06
	4317.85	229.9	61.33	-1713.39	-1593.25	4321.54	F	0.48
	4322.93	298.79	11.74	-1713.32	-1593.45	4326.62	J	0.14
	4323.27	202.09	15.00	-1713.31	-1593.46	4326.96	C?	0.07
	4323.3	171.42	6.47	-1713.31	-1593.47	4326.99	J	0.07
	4324.62	298.49	53.05	-1713.29	-1593.52	4328.31	F	0.41
129	4327.49	150.64	61.33	-1713.25	-1593.63	4331.18	F	0.48
130	4329.66	191.5	66.93	-1713.22	-1593.72	4333.35	F1	0.46
	4330.88	276.42	14.39	-1713.2	-1593.76	4334.56	C?	0.14
	4333.19	138.49	79.19	-1713.17	-1593.85	4336.87	F	0.59
	4337.33	204.02	59.57	-1713.11	-1594.02	4341.01	F	0.73
	4342.02	24.13	13.8	-1713.04	-1594.2	4345.69	J?	0.13
	4343.05	174.87	22.28	-1713.03	-1594.24	4346.72	J?	0.13
	4345.68	57.77	15.4	-1712.99	-1594.35	4349.35	J	0.06
	4346.23	232.88	42.15	-1712.98	-1594.37	4349.9	F?	0.46
	4348.3	304.02	2.27	-1712.95	-1594.45	4351.97	J	0.05
139	4354.37	132.83	62.75	-1712.86	-1594.69	4358.03	F?	0.62
140	4356.27	94.7	50.91	-1712.83	-1594.76	4359.93	F?	0.30
	4356.97	113.63	8.87	-1712.82	-1594.79	4360.63	J	0.04
	4359.46	115.04	65.32	-1712.79	-1594.89	4363.12	F?	0.3
	4363.71	50.82	17.72	-1712.73	-1595.05	4367.36	F1	0.08
	4368.25	172.87	5.69	-1712.66	-1595.23	4371.9	J	0.06
	4368.81	120.31	33.8	-1712.65	-1595.25	4372.46	F?	0.17
	4372.35	76.51	34.54	-1712.6	-1595.39	4376	F1	0.13
	4373.38	81.83	8.66	-1712.59	-1595.43	4377.02	J	0.06
	4375.9	261.01	35.72	-1712.55	-1595.53	4379.54	F?	0.14
149	4378.36	9.75	12.5	-1712.51	-1595.63	4382	J	0.1
150	4379.55	91.75	61.86	-1712.5	-1595.68	4383.19	F1	0.35
	4381.86	55.22	19.15	-1712.46	-1595.77	4385.49	J	0.12
	4383.15	221.78	26.13	-1712.44	-1595.82	4386.79	J	0.18
	4386.69	271.48	4.49	-1712.39	-1595.96	4390.33	J	0.07
	4387.97	170.28	24.86	-1712.37	-1596.01	4391.6	J	0.33
	4388.25	78.08	20.07	-1712.37	-1596.02	4391.88	J	0.1
	4388.91	100.57	7.27	-1712.36	-1596.04	4392.54	J	0.03
	4390.16	89.49	27.64	-1712.34	-1596.09	4393.79	F	0.08
	4391.15	159	6.22	-1712.33	-1596.13	4394.78	J	0.05
159	4392.29	82.4	21.42	-1712.31	-1596.18	4395.91	F	0.09

TABLE VI (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
160	4394.7	61.57	21.54	-1712.28	-1596.27	4398.32	F	0.08
	4395.82	297.84	2.6	-1712.25	-1596.32	4399.44	J	0.02
	4396.72	54.28	24.03	-1712.25	-1596.35	4400.34	F	0.09
	4397.46	61.57	23.1	-1712.24	-1596.38	4401.08	F	0.11
	4404.59	85.9	14.5	-1712.14	-1596.66	4408.21	J	0.08
	4405.21	49.18	10.02	-1712.13	-1596.68	4408.82	J	0.09
	4406.49	300.26	5.02	-1712.12	-1596.73	4410.1	C?	0.09
	4411.58	168.64	19.44	-1712.05	-1596.93	4415.2	F?	0.12
	4413.04	186.85	4	-1712.03	-1596.99	4416.65	J	0.05
169	4413.56	155.15	25.67	-1712.02	-1597.01	4417.17	F?	0.05
170	4419.46	247.46	20.96	-1711.95	-1597.24	4423.06	F?	0.05
	4424.41	36.06	73.75	-1711.88	-1597.43	4428.01	F?	0.12
	4432.3	270.11	17.68	-1711.78	-1597.74	4435.89	J	0.03
	4432.9	285.99	18.8	-1711.77	-1597.77	4436.49	J	0.06
	4441.73	129.01	33.36	-1711.66	-1598.11	4445.31	F?	0.21
	4443.93	67.43	16.98	-1711.63	-1598.2	4447.51	J	0.13
	4447.13	291.12	51.08	-1711.59	-1598.32	4450.72	F?	0.19
	4448.87	338.36	25.46	-1711.56	-1598.39	4452.45	J	0.1
	4449.07	308.81	7.15	-1711.56	-1598.4	4452.65	J	0.01
179	4449.58	348.51	6.25	-1711.56	-1598.42	4453.16	J	0.02
180	4450.03	72.08	7.63	-1711.55	-1598.44	4453.61	J	0.03
	4450.88	48.11	20.65	-1711.54	-1598.47	4454.46	J	0.07
	4456.19	178.32	19.04	-1711.47	-1598.68	4459.77	J	0.05
	4457.68	179.15	15.67	-1711.45	-1598.74	4461.26	J	0.02
	4461.21	201.89	4.51	-1711.4	-1598.87	4464.78	J	0.08
	4466.71	206.58	25.72	-1711.33	-1599.09	4470.27	Js	0.04
	4470.34	106.68	24.88	-1711.29	-1599.23	4473.91	J	0.07
	4477.55	35.34	22.36	-1711.19	-1599.51	4481.1	J	0.09
	4477.97	71.01	11.5	-1711.19	-1599.53	4481.52	J	0.04
189	4478.04	195.97	25.4	-1711.19	-1599.53	4481.6	J?	0.18
190	4479.09	71.69	4.97	-1711.17	-1599.57	4482.65	J	0.01
	4481.44	102.97	23.93	-1711.14	-1599.66	4485	J	0.1
	4485.61	112.14	13.72	-1711.09	-1599.83	4489.16	J?	0.08
	4486.87	201.35	9.51	-1711.07	-1599.88	4490.42	J	0.06
	4488.38	197.41	26.22	-1711.05	-1599.94	4491.93	J?	0.08
	4489.14	354.48	22.33	-1711.04	-1599.97	4492.69	F?	0.16
	4491.07	274.23	10.99	-1711.02	-1600.04	4494.61	C?	0.02
	4494.44	340.46	25.41	-1710.97	-1600.17	4497.98	F	0.1
	4496.04	57.85	7.74	-1710.95	-1600.24	4499.59	J	0.04
199	4496.57	0.51	28.54	-1710.94	-1600.26	4500.11	F	0.25

TABLE VI (cont)

Depth Downhole No.	(ft)	Orientation		Location			Type	Fit (ft)
		Azimuth (deg)	Inclination (deg)	North (ft)	East (ft)	Down (ft)		
200	4498.04	12.76	26.86	-1710.93	-1600.31	4501.58	F	0.25
	4499.36	194.14	5.99	-1710.91	-1600.36	4502.9	J	0.04
	4504.22	139.06	15.3	-1710.85	-1600.55	4507.76	J	0.14
	4510.94	184.69	17.63	-1710.78	-1600.8	4514.47	J	0.11
	4511.33	25.81	37.64	-1710.78	-1600.82	4514.86	F	0.28
	4514.9	14.22	26.61	-1710.74	-1600.95	4518.43	F	0.12
	4519.55	348.66	20.73	-1710.68	-1601.13	4523.08	F	0.12
	4526.46	2.2	27.92	-1710.61	-1601.39	4529.98	Fs	0.12
	4526.58	76.52	11.46	-1710.61	-1601.4	4530.1	J	0.09
209	4530.68	345.77	24.11	-1710.56	-1601.55	4534.2	F	0.1
210	4534.84	351.43	31.55	-1710.52	-1601.71	4538.35	F	0.31
	4538.23	12.98	44.33	-1710.48	-1601.84	4541.74	F	0.07
	4540.35	1.61	30.93	-1710.46	-1601.92	4543.86	F	0.05
	4545.51	350.59	26.18	-1710.4	-1602.12	4549.02	F1	0.12
	4555.89	225.44	71.14	-1710.29	-1602.51	4559.39	F?	0.49
	4562.88	101.47	8.27	-1710.21	-1602.77	4566.37	J	0.02
216	4564.46	62.08	30.05	-1710.15	-1603.13	4567.93	F	---

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