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WESTERN CANADA SEDIMENTARY BASIN
BOREHOLE IMAGERY ANALYSIS PROJECT:
A SUMMARY OF MOBIL Mikwa River 10-22-98-3W5

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Although every effort has been made to ensure accuracy, this Open File Report has not been edited for conformity with Geological Survey of Canada standards.

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**Western Canada Sedimentary Basin Borehole Imagery Analysis
Project: A Summary of MOBIL Mikwa River 10-22-98-3W5**

Well Name: MOBIL Mikwa River 10-22-98-3W5

Operator: Mobil Oil

Location: latitude 57° 31' 16.4" N.
longitude 114° 23' 21.4" W.
(see figure 1)

Rig Release Date: January 25, 1991

Imagery Log/Interval Logged: FMS 791.9 - 1251.5 m

Well Trajectory: Semi-vertical, deviated

Drill Bit Size: 8.5 inches over the interval logged

Formations Logged and Tops:	Devonian Slave Point	832.5 m
	Devonian Fort Vermillion	843.0 m
	Devonian Watt Mountain	872.5 m
	Devonian Muskeg	884.5 m
	Devonian Keg River	1147.5 m
	Devonian Chinchaga	1182.0 m
	Devonian Granite Wash	1226.5 m

Lithologies: The section logged consists largely of Devonian Beaverhill Lake carbonates, comprised of the Slave Point and Fort Vermillion Formations, and Elk Point carbonates comprised of the Watt Mountain, Muskeg, Keg River, Chinchaga and Granite Wash Formations.

Core Intervals: No cores cut.

Structural Setting: East flank of the Western Canada Sedimentary Basin.

Regional Stress trajectories: The nearest well with stress orientation data is Total Union et al Rede 6-29-88-7W5 located 104.6 kms SE with a $S_{H\min}$ direction of 133.9° N (Bell et al, 1994).

Description of Images:

Discontinuous Semi-Vertical Fractures: Three semi-vertical discontinuous fractures were observed in the interval logged and examples are given in figures 3, 4 and 5. The fractures are characterized by thin, discontinuous, dark (conductive) traces appearing 180° apart on the FMS microresistivity images. The interpretive software program BORVIEW converts digital

microresistivity contrasts into brown-yellow tones (dark colors indicate high conductivity whereas light colors indicate low conductivity, Bourke et al 1989) and applies a sinusoidal curve to arrive at a true dip angle and dip azimuth.

Natural Fractures: Figures 5 and 6 illustrate examples of naturally occurring fractures in MOBIL Mikwa River 10-22-98-3W5. Nineteen natural fractures were measured. These fractures are characterized by dark, continuous traces which can generally be seen on all sides of the borehole wall. This permits an excellent fit by the BORVIEW workstation software and results in accurate orientation measurements.

Borehole Breakouts: Borehole breakouts are measured by the four oriented arms of the FMS calipers to determine the profile of the wellbore (Plumb and Hickman, 1985). In the presence of anisotropic horizontal stresses borehole collapse may occur on opposite sides of the wellbore at the azimuths of the minimum horizontal stress directions ($S_{H\min}$). The calipers will indicate a corresponding long axis where spalling has occurred and a perpendicular short axis near bit size. When the FMS tool is raised through a breakout zone, tool rotation will cease if the pads become entrenched within the zone. Frequently the pads themselves will be unable to make firm contact with the borehole wall in the spalled zone and a diffuse, unfocussed image will result.

Only an early stage of breakout development has been observed in Mikwa River 10-22-98-3W5. *Incipient breakout* is illustrated in figures 7 and 8. The dark, linear fracture trace observed on the microresistivity image is interpreted as a shear fracture that intersects the borehole wall in response to the anisotropic stresses acting upon it. There is only minimal lateral borehole elongation.

Bedding Planes: Twenty-seven measurements of bedding planes were made at regular intervals to supplement the data set. Figures 6 illustrates an example.

Results:

Discontinuous Semi-Vertical Fractures: In MOBIL Mikwa River 10-22-98-3W5 three semi-vertical fractures are found throughout the interval logged by the FMS tool. On FMS microresistivity images they are characterized by thin, discontinuous, dark (conductive), linear traces that approximately parallel borehole trajectory, cross-cut bedding, and are open and mud-filled. They occur 180° apart on the images and range in length from 0.2 m to 0.5 m. Strike azimuths are summarized in figure 11a. The mean strike from 3 samples is 81.2° +/- 9.0°.

It is believed that these fractures form as hydraulic fractures in response to pressure exerted on the undrilled rock by the weight of the drillstem during drilling. Alternatively, fracture generation may be the result of the drillpipe acting as a loose fitting piston when it is run into the hole too quickly. This action will cause bottomhole pressures to exceed the parting pressure of the rocks (Dickey, 1986).

Hydraulic fractures propagate within the plane formed by the largest and intermediate principal stresses (S_v and $S_{H\max}$) and are extensional. S_v is vertical and thus induced fractures can be used to detect the direction of the maximum horizontal principal stress ($S_{H\max}$). As figure 11a illustrates, this would give an $S_{H\max}$ azimuth of 081.2° N.

Natural Fractures: Natural fractures are caused by stresses that have acted upon the rocks at some point in the past and unlike drilling induced fractures their orientations cannot be taken as indicative of the current stress regime. They appear to be concentrated towards the bottom of the section logged in the Granite Wash Formation (see figure 2). Figure 11b summarizes the orientations of the 19 naturally occurring fractures measured in Mikwa River 10-22-98-3W5. A mean strike for the fracture set is computed as $175.1^\circ \pm 40.4^\circ$. These thin planar preexisting fractures are open and crosscut bedding and may be nearly perpendicular to it.

Borehole Breakouts: A stress regime characterized by anisotropic horizontal stresses acting on the borehole will often result in borehole collapse on opposite sides of the well. Borehole breakouts form when shear fractures develop subparallel to the borehole wall and extend the well in a direction parallel to $S_{H\min}$. As these fractures propagate, portions of the borehole wall spall off creating an "ovalized" borehole. These features are excellent indicators of the direction of the minimum horizontal stress orientation $S_{H\min}$, although cable torque on the tool may bias results slightly (Parker and Heffernan, 1992). While no clear examples of borehole wall collapse have been observed in the study well, two examples of fracture traces associated with possible incipient breakout have been observed (figures 7 and 8). Figure 12a summarizes the orientations of the two observed incipient borehole breakouts (mean azimuth = $150.0^\circ \pm 15.1^\circ$).

This would suggest a mean $S_{H\min}$ direction of 150.0° N for Mikwa River 10-22-98-3W5.

Bedding Planes: Measured bedding plane orientations are summarized in figure 12b.

Feature Orientation Summaries: Figure 2 is a well overview diagram that summarizes the depth and strike and dip of each of the features mapped in this study. Figure 10 is a Wulf stereonet summary diagram that shows dip angles and dip azimuths of the features. Incipient breakouts locations show strike orientations.

Conclusions

As the above discussion makes clear Mikwa River 10-22-98-3W5 does not exhibit well developed or obvious drilling-induced fractures. The most frequently encountered features are medium to low angle natural fractures with various strikes. At this stage in the Geological Survey of Canada's Borehole Imagery investigations it is not clear whether the geomechanical response of this well is typical of a shallow hole on the east flank of the western Canada sedimentary basin. Earlier studies (Bell and Babcock, 1986) found that breakout occurrence and development tended to diminish eastwards across the basin. If this finding is sustained it may indicate a decrease in stress anisotropy from west to east in the WCSB.

The measurements made from features observed on FMS microresistivity images in Mikwa River 10-22-98-3W5 suggest a mean $S_{H\max}$ direction of 081.2° N. This orientation differs from the regional trend of $S_{H\max}$ as summarized in figure 1. The mean $S_{H\min}$ direction of 150.0° N differs only marginally from the $S_{H\min}$ direction derived from oriented caliper logs from the nearby well Total Union et al Rede 6-29-88-7W5, with a value of 133.9° N. (see figure 1).

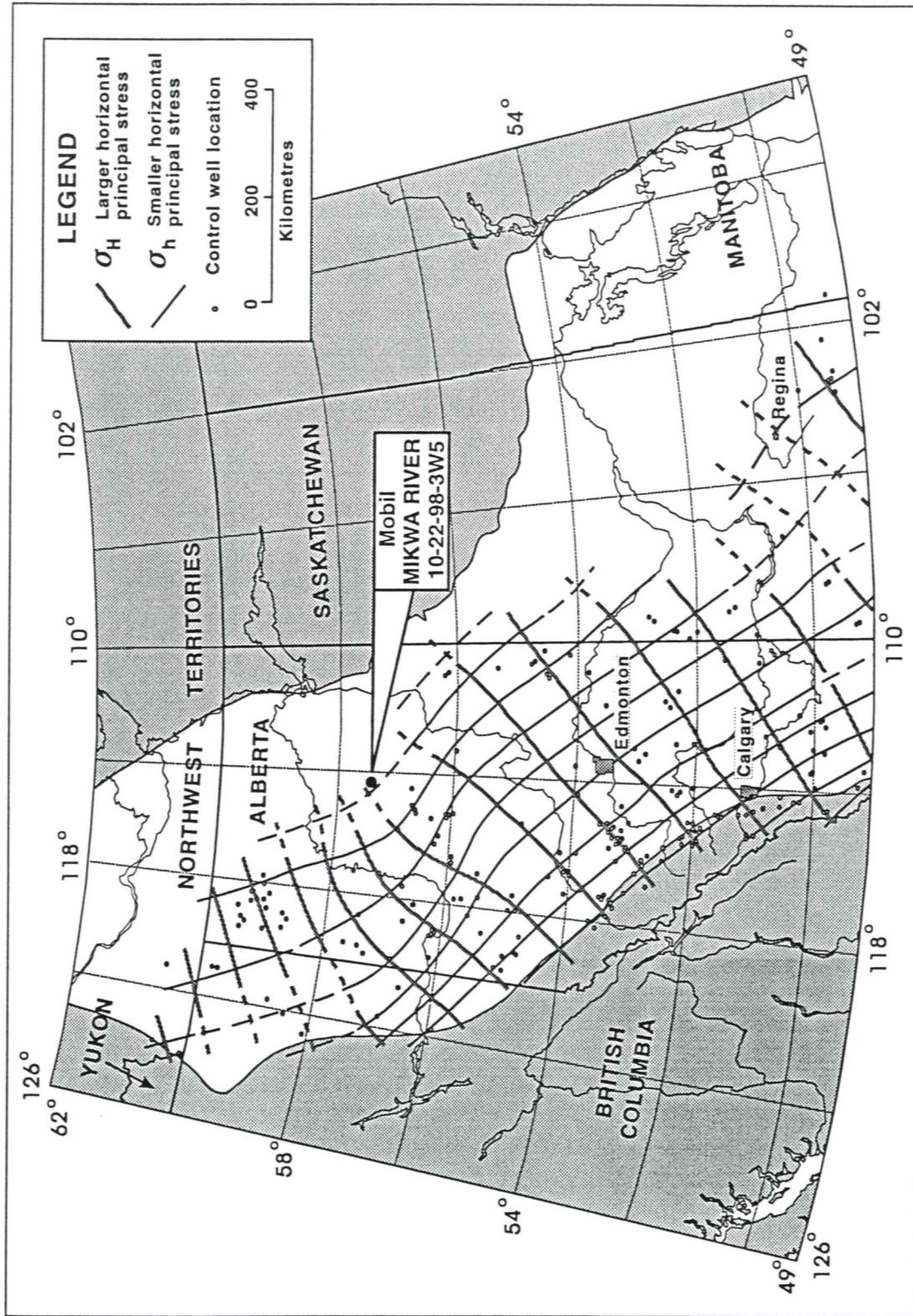
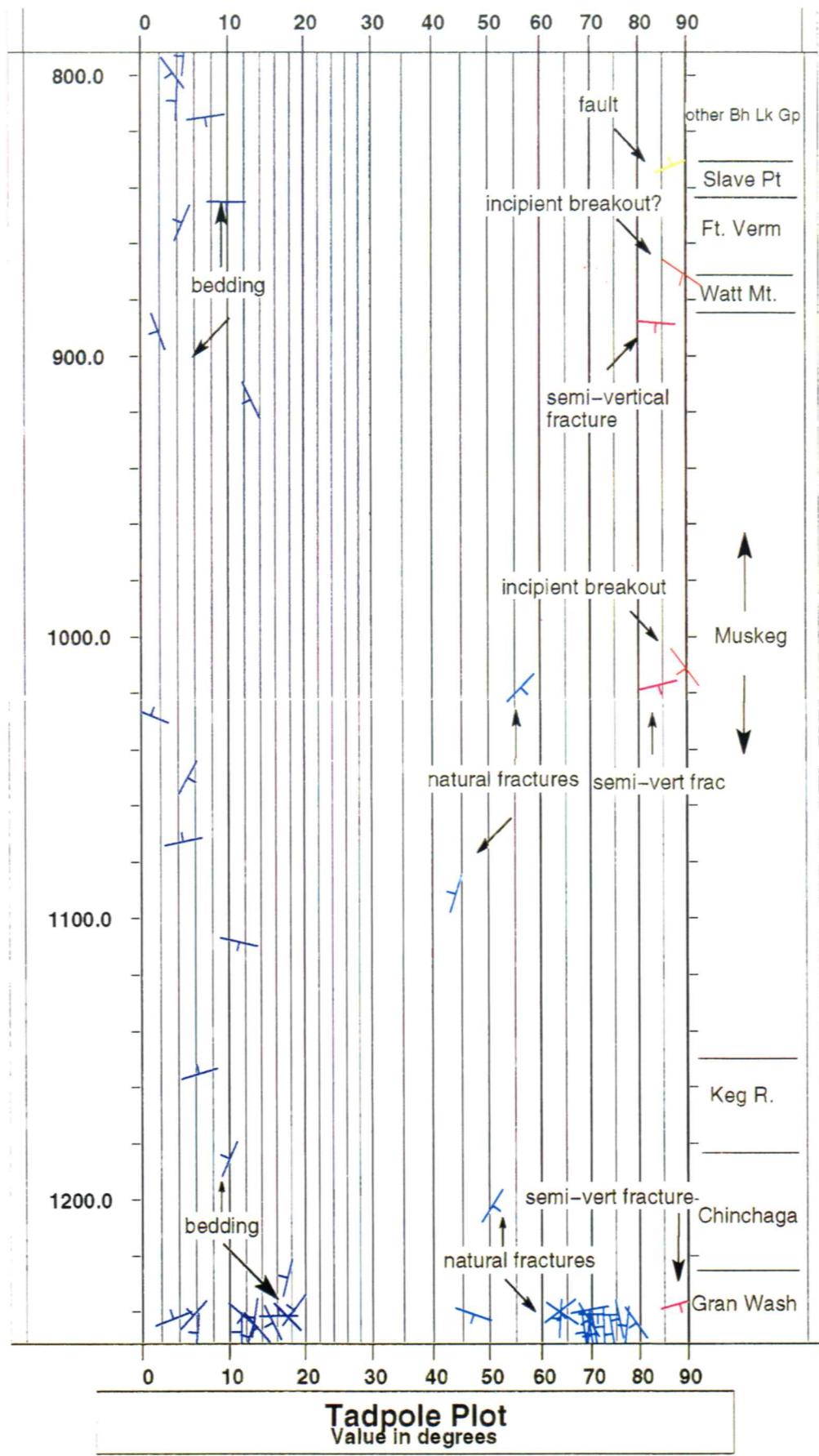


Figure 1. Location of Mikwa River 10-22-98-3W5 with respect to the stress regime of the Western Canada Sedimentary Basin.

Figure 2. A well overview diagram of the entire Mikwa River 10-22-98-3W5 well summarizing strike and dips of the various features observed.



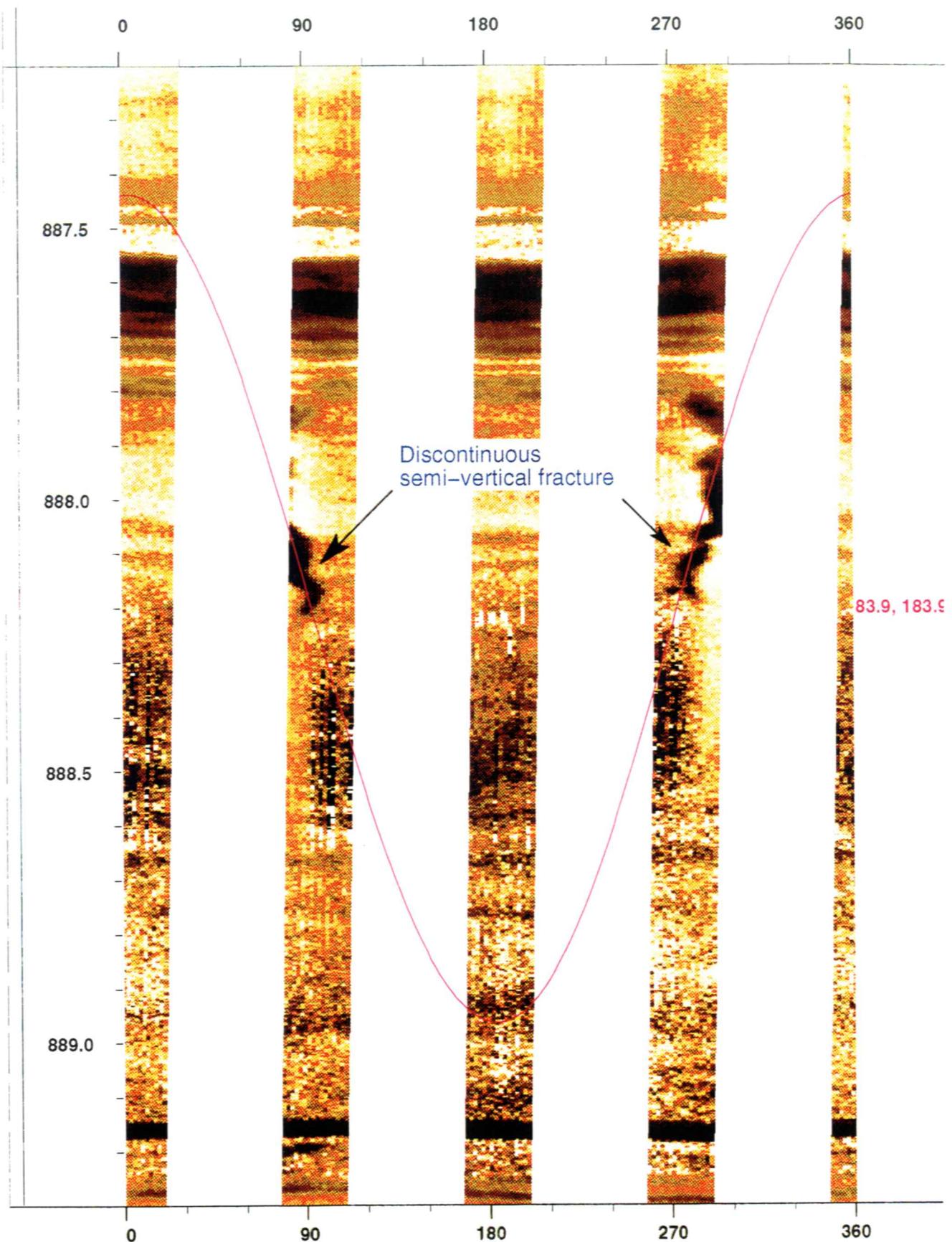


Figure 3. A semi-vertical fracture at the 888.0 m mark within Devonian Muskeg Formation. The fracture is characterized by a discontinuous linear, dark (conductive) trace appearing at opposite sides of the borehole at azimuths of 080° and 290°. It dips at 84° with a dip azimuth of 184° (strike direction 094° N). Vertical scale is 1:10, horizontal scale is 1:5.

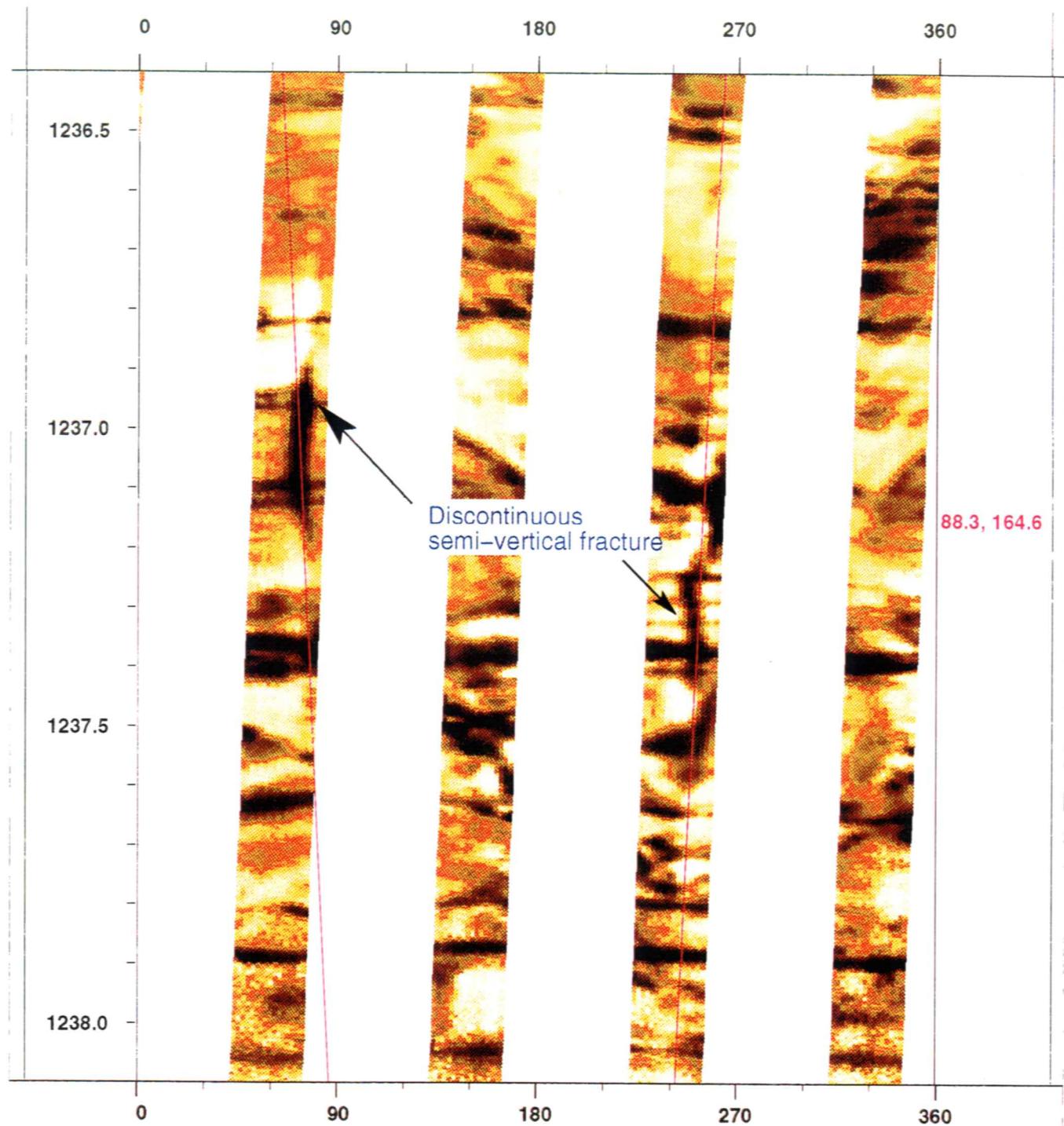


Figure 4. A discontinuous semi-vertical fracture at the 1237.0 m mark within Devonian Granite Wash clastics. The fracture dips at 88° with a dip azimuth of 165° (strike 075° N). Vertical scale is 1:10, horizontal scale is 1:5.

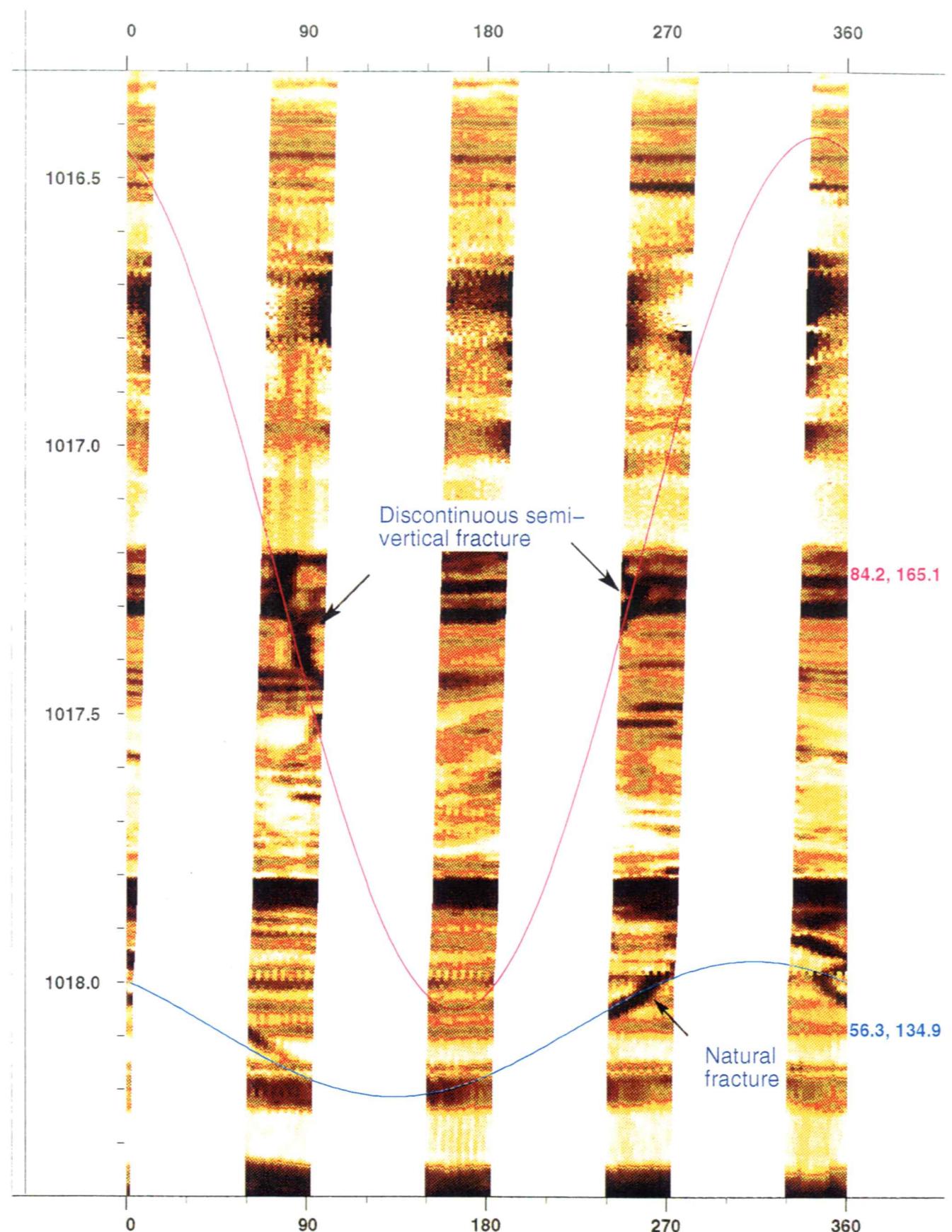


Figure 5. A discontinuous semi-vertical fracture dipping 84° and striking 075° within the Devonian Muskeg Formation. The natural fracture at 1018.0 m exhibits a dark (conductive), continuous trace dipping less steeply than the induced semi-vertical fracture and observed on all sides of the borehole. Vertical scale is 1:20, horizontal scale is 1:5.

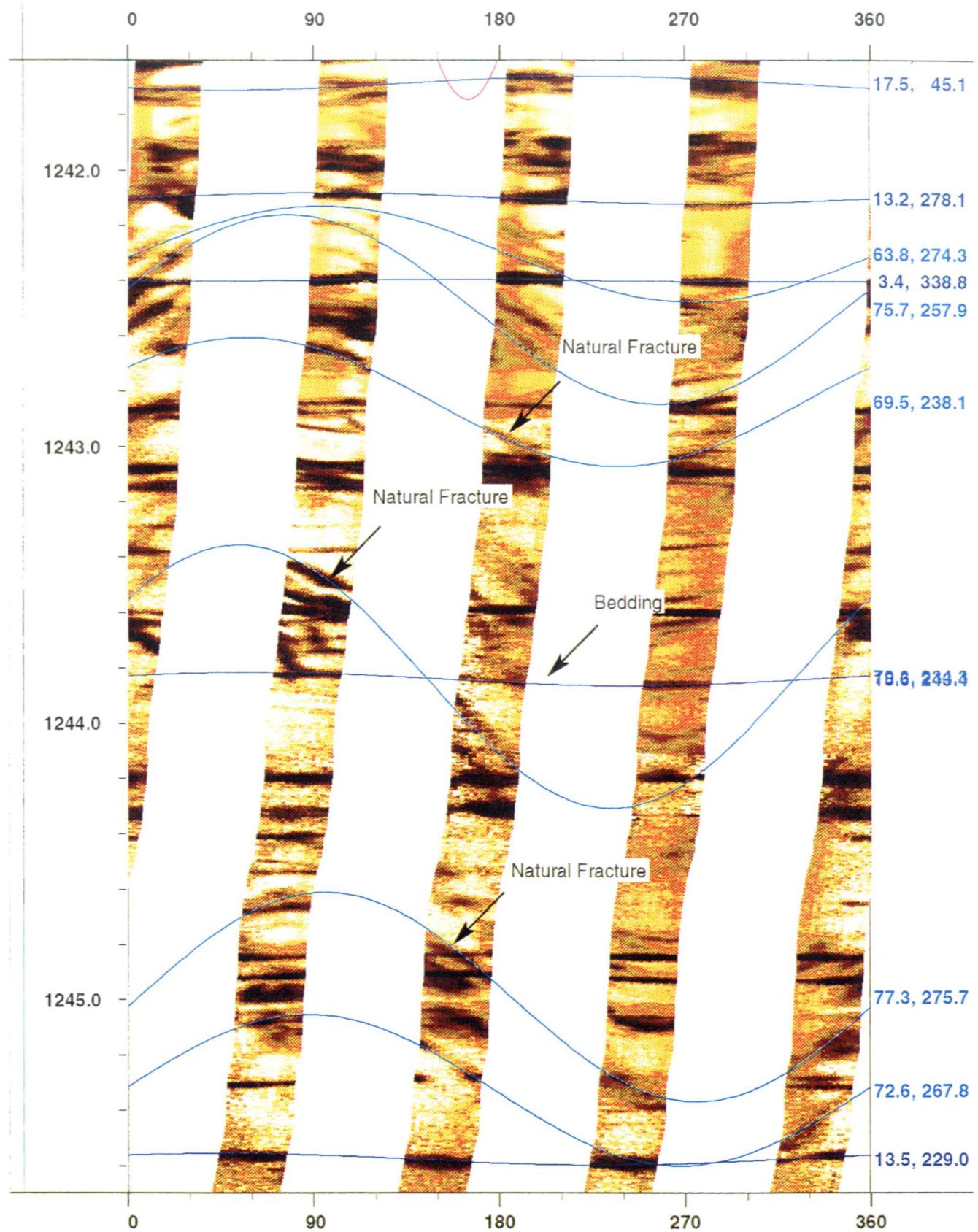


Figure 6. Natural fractures within the Devonian Granite Wash Formation at the 1242.0 to 1245.6 m interval. Note the continuous traces on all sides of the borehole wall. Bedding planes are measured. Vertical scale is 1:20, horizontal scale is 1:5.

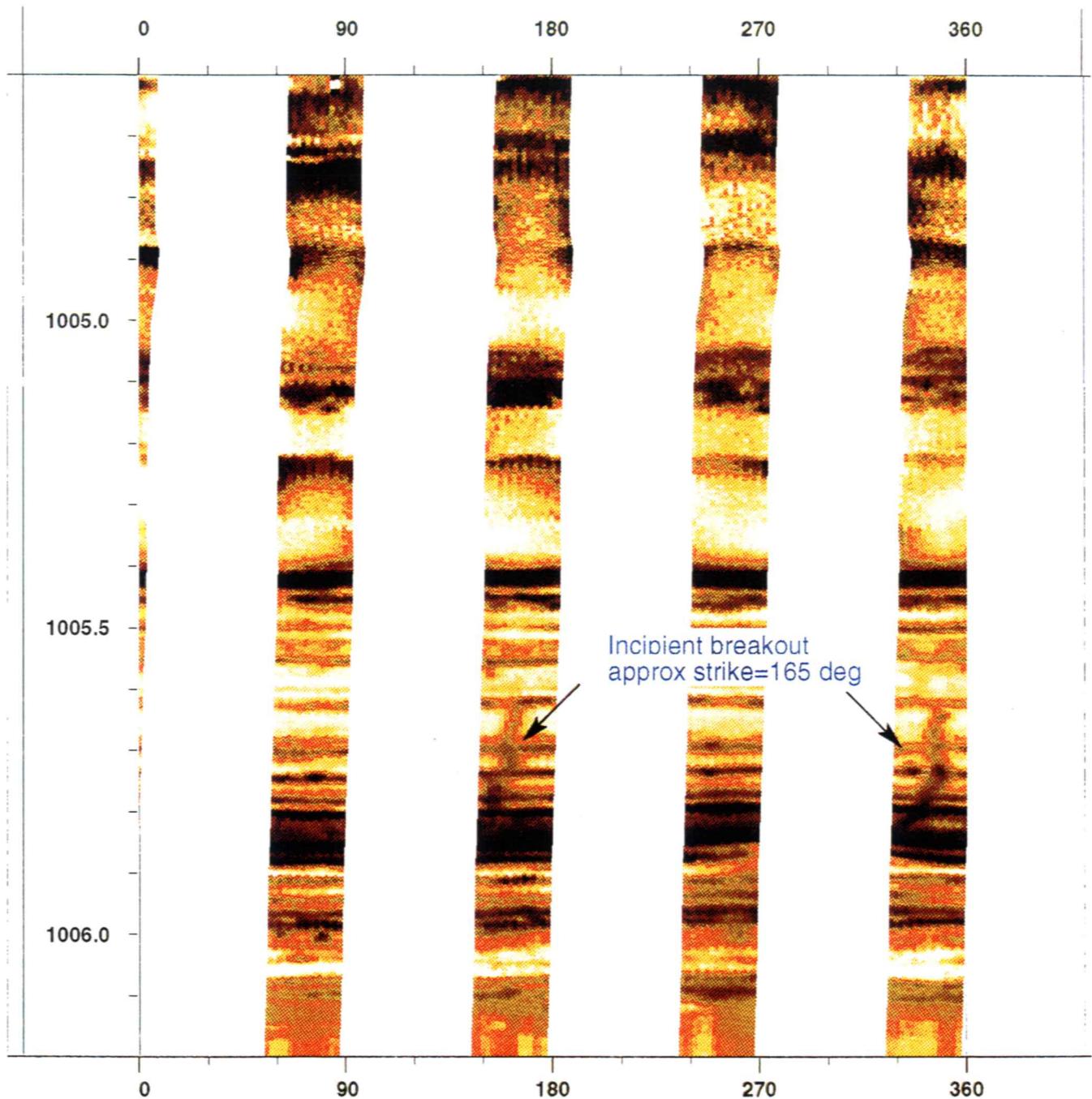


Figure 7. An example of a fracture trace associated with incipient borehole breakout at the 1005.5 m mark within the Devonian Muskeg Formation. The fracture traces align themselves at an approximate azimuth of 165° and represent the beginnings of borehole collapse as shear fractures intersect the borehole wall. Vertical scale is 1:10, horizontal scale is 1:5.

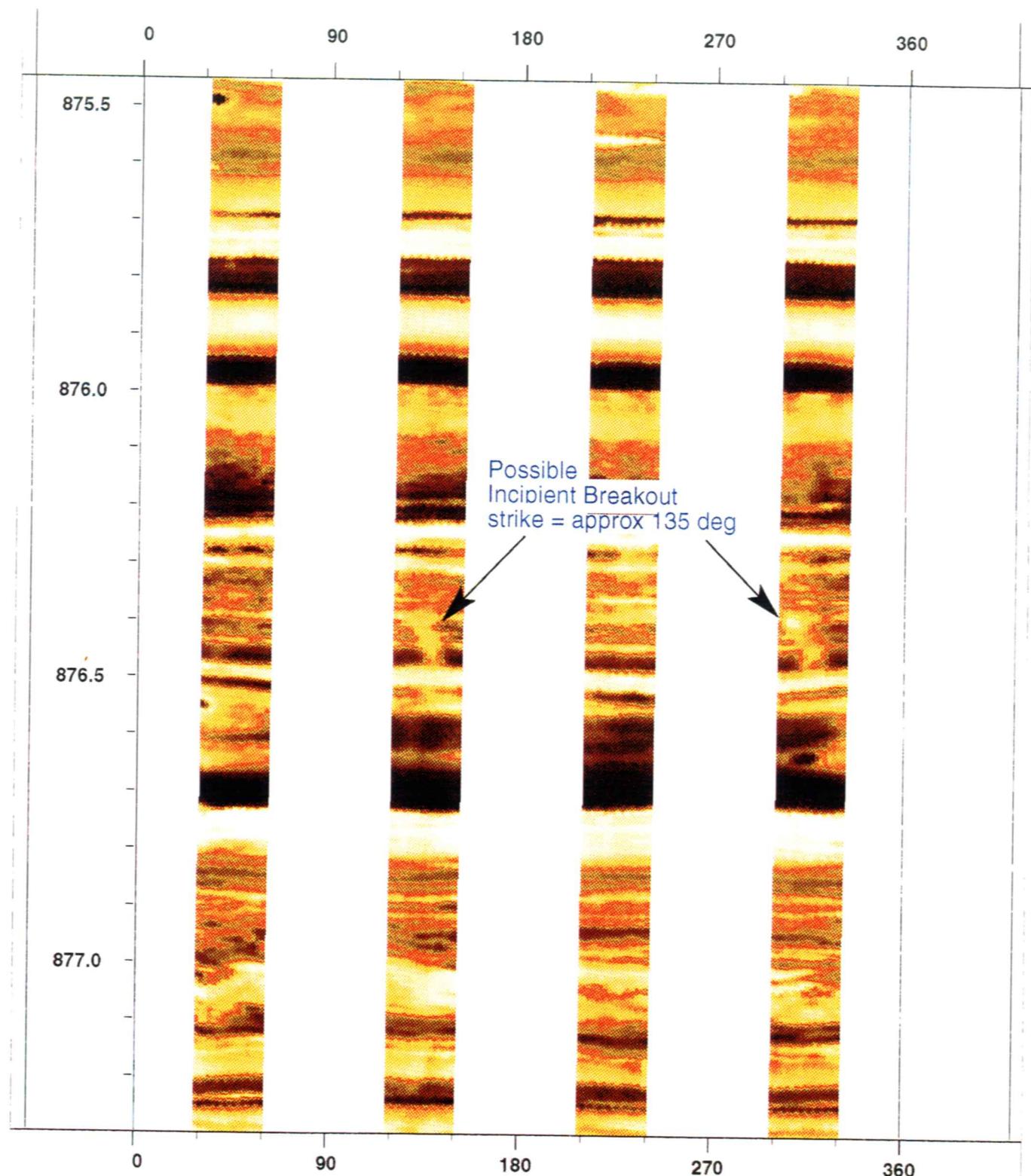


Figure 8. An example of a fracture trace associated with a suspected incipient borehole breakout at the 876.4 m mark within the shales of the Devonian Watt Mountain Formation. The fracture traces align themselves at an approximate azimuth of 135° and represent the beginnings of borehole collapse as shear fractures intersect the borehole wall. Vertical scale is 1:10, horizontal scale is 1:5.

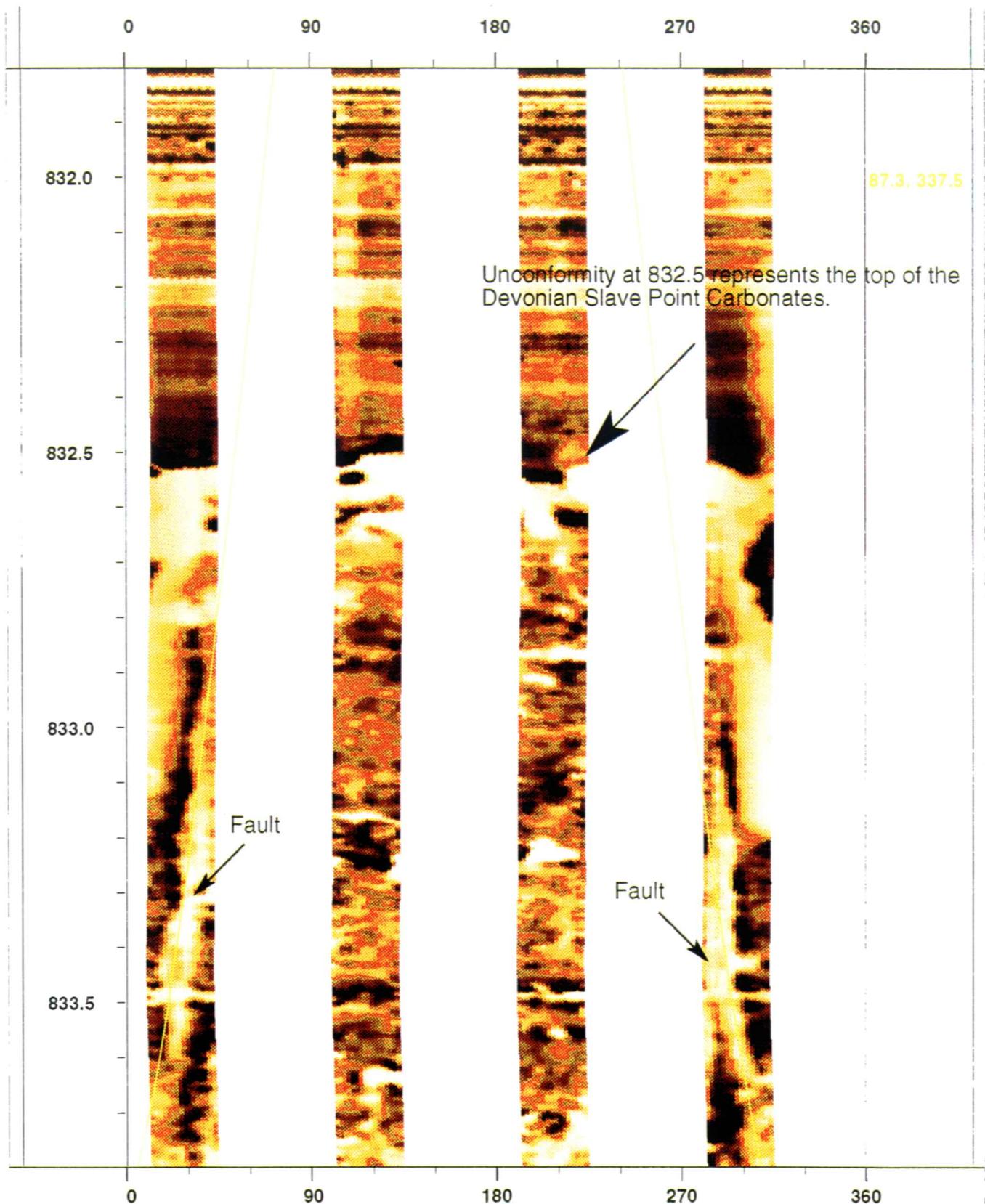


Figure 9. A linear feature at the top of the Devonian Slave Point carbonates interpreted as a steeply dipping (87°) fault trace that intersects the northern quadrant of the borehole. At the unconformity surface the trace intersects the borehole wall at approximate azimuths of 290° N and 045° N. The resistive (white) fault plane indicates the fault plane has undergone some mineralization. Vertical scale is 1:10, horizontal scale is 1:5.

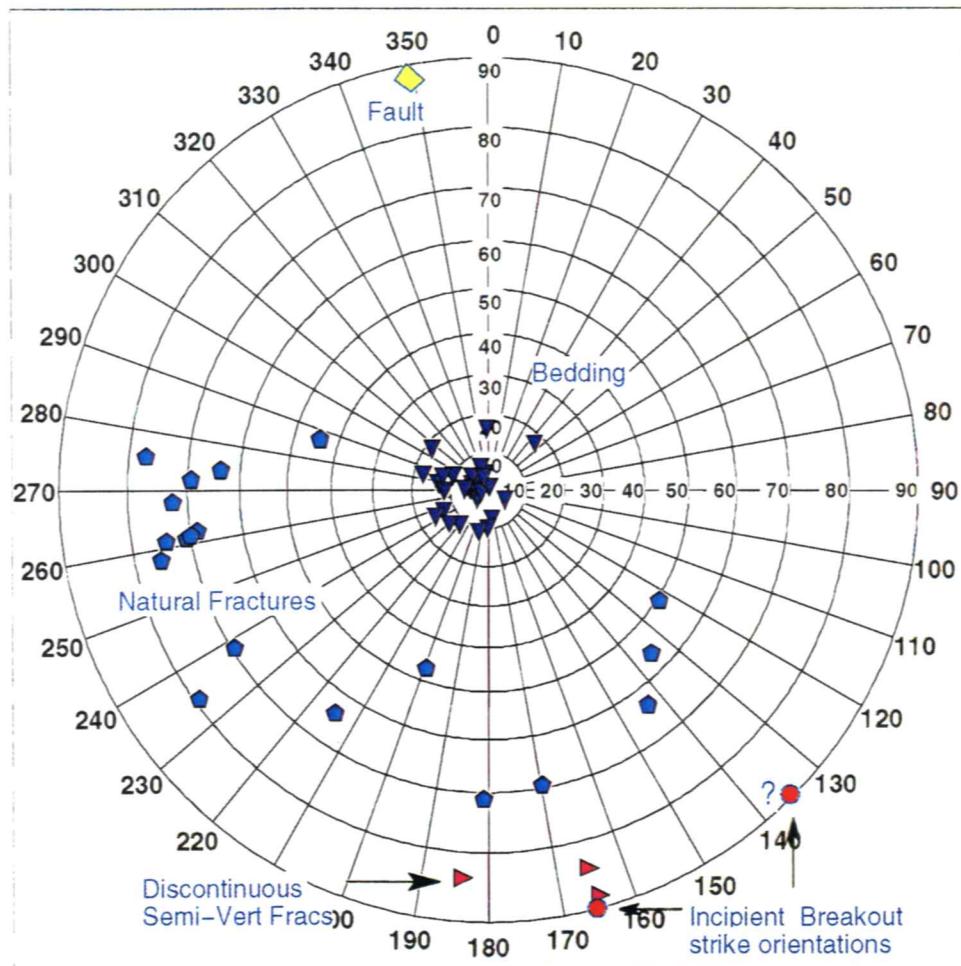


Figure 10. Wulff stereonet summary diagram of all features types in Mikwa River 10-22-98-3W5. The diagram shows dip angles and dip azimuths of the features. The incipient breakout locations depict strike orientations.

Figure 11a. Strike azimuth plot of semi-vertical fractures in Mikwa River 10-22-98-3W5. Mean strike from 3 samples is computed as $081.2^\circ \pm 9.0^\circ$.

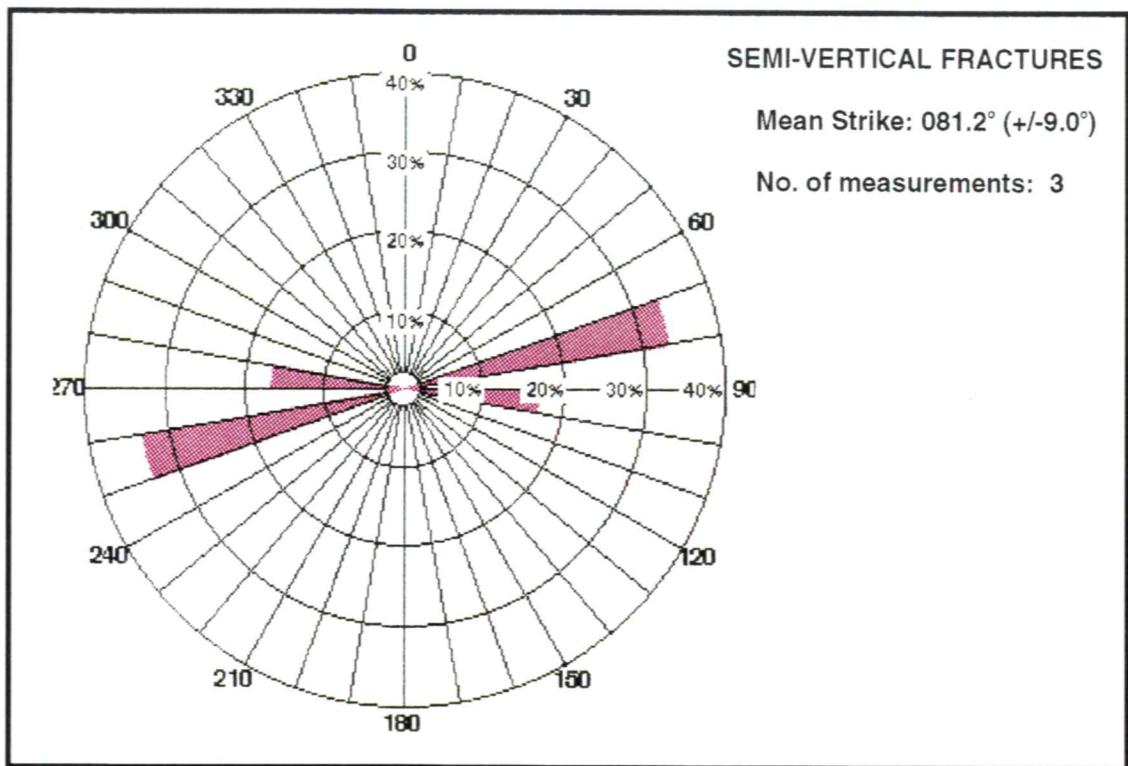


Figure 11b. Strike azimuth plot of naturally occurring fractures in Mikwa River 10-22-98-3W5. Mean strike for 19 samples is computed as $175.1^\circ \pm 40.4^\circ$.

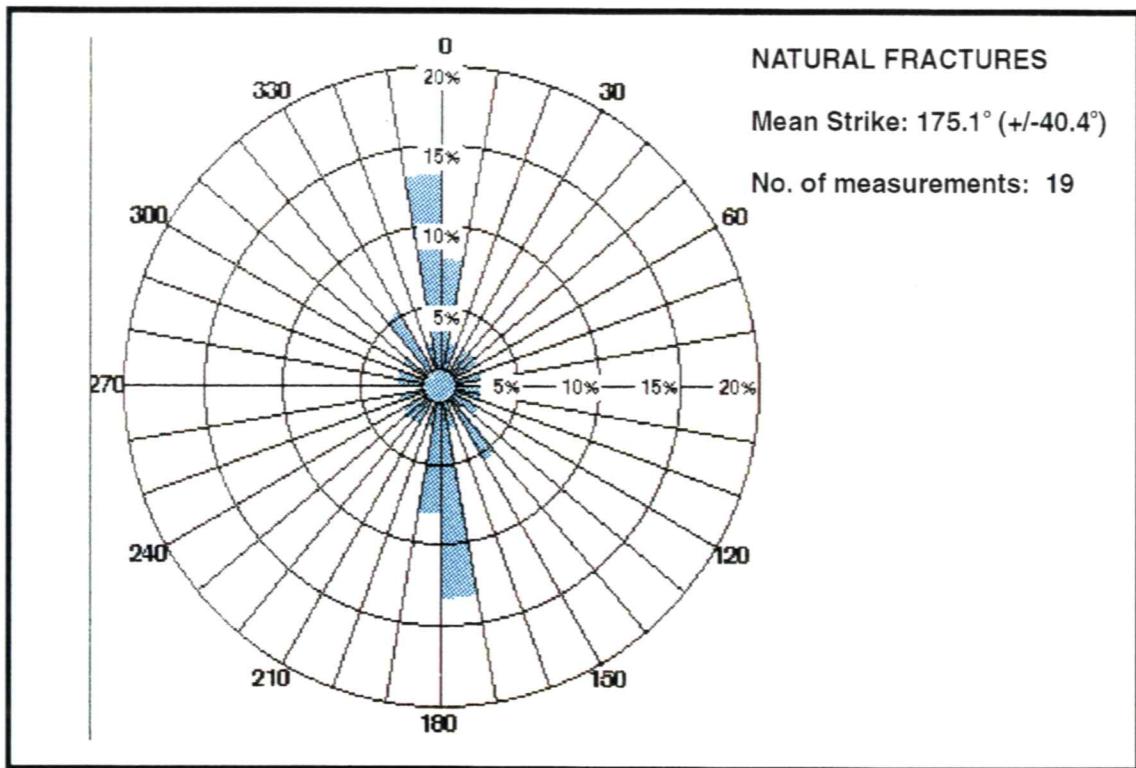


Figure 12a. Azimuth plot of the 2 incipient breakouts observed in Mikwa River 10-22-98-3W5. Mean azimuth is computed as $150.0^\circ \pm 15.1^\circ$.

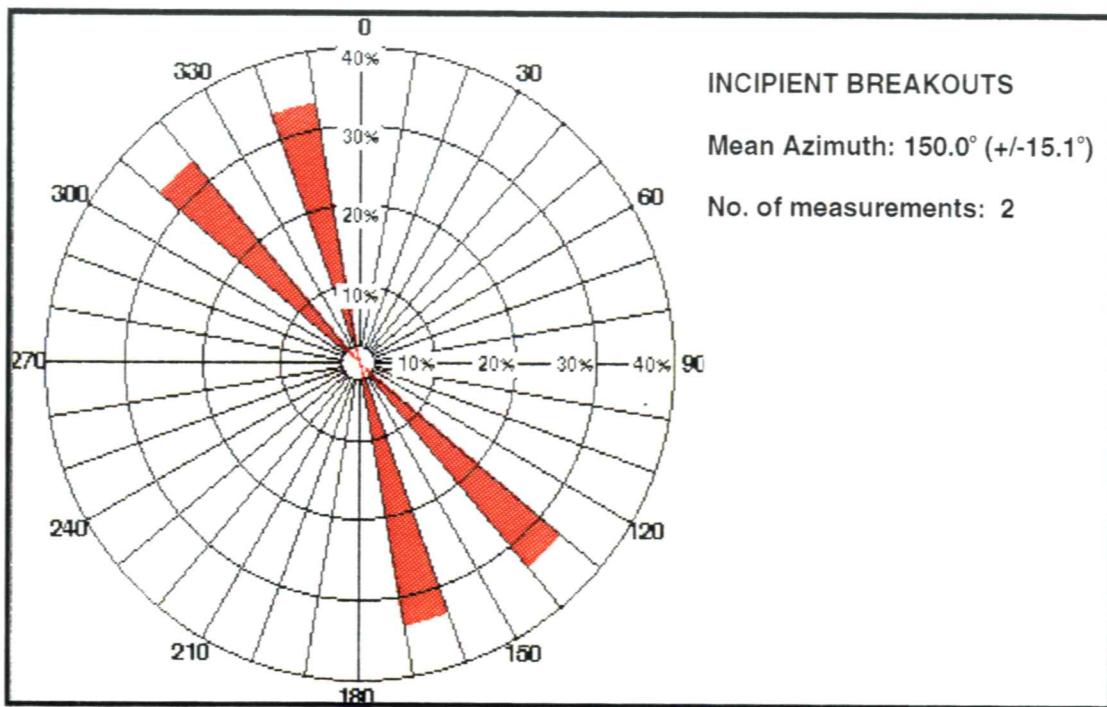
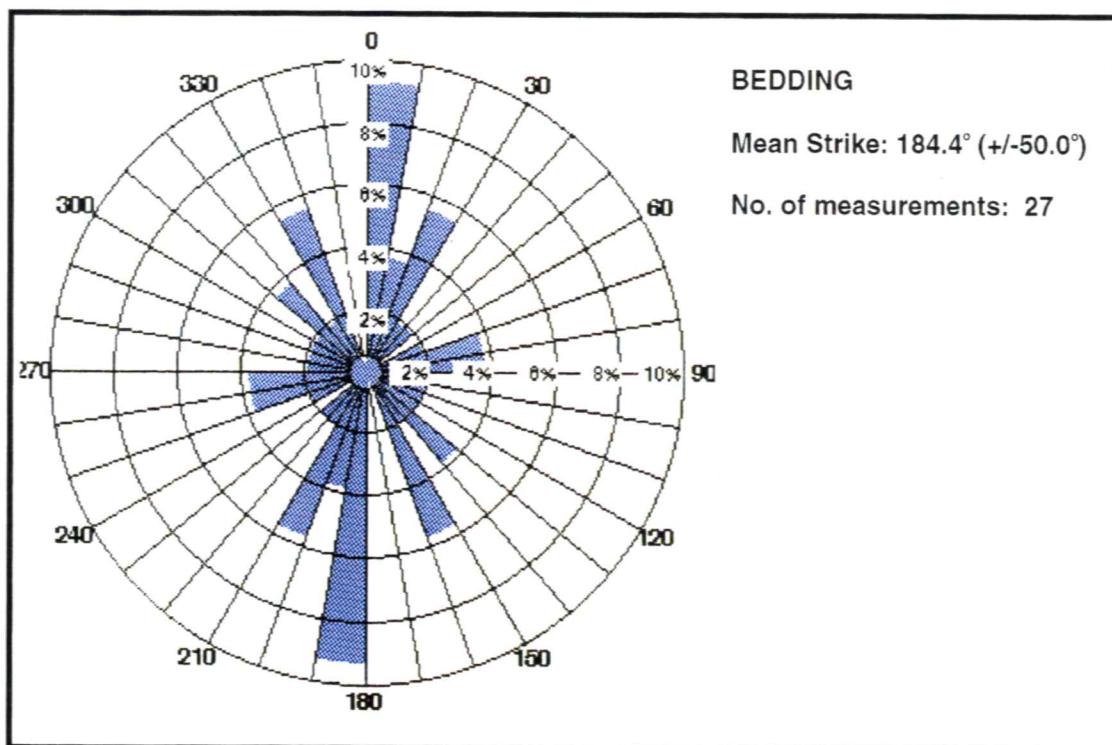


Figure 12b. Strike azimuth plot of bedding planes measured in Mikwa River 10-22-98-3W5. Mean strike for the 27 measured samples is computed as $184.4^\circ \pm 50.0^\circ$.



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June, p.304-312.

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Well Name: Mobil MIKWA RIVER 10-22-98-3W5							
Semi-Vertical Fractures							
Depth KB m	Azimuth of feature	Sin Azi	Cumulative Total Sin Azi	Cos Azi	Cos Azi corrected for zero values	Cumulative Total Cos Azi	Measurement made or not 1 or 0 entered
793.2	0.0	0.000	0.000	1.000	0.000	0.000	0
798.8	0.0	0.000	0.000	1.000	0.000	0.000	0
809.1	0.0	0.000	0.000	1.000	0.000	0.000	0
815.0	0.0	0.000	0.000	1.000	0.000	0.000	0
833.0	0.0	0.000	0.000	1.000	0.000	0.000	0
844.9	0.0	0.000	0.000	1.000	0.000	0.000	0
852.2	0.0	0.000	0.000	1.000	0.000	0.000	0
876.4	0.0	0.000	0.000	1.000	0.000	0.000	0
888.2	273.9	-0.998	-0.998	0.068	0.068	0.068	1
891.0	0.0	0.000	-0.998	1.000	0.000	0.068	0
915.5	0.0	0.000	-0.998	1.000	0.000	0.068	0
1005.7	0.0	0.000	-0.998	1.000	0.000	0.068	0
1017.2	255.1	-0.966	-1.964	-0.257	-0.257	-0.189	1
1018.1	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1027.9	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1050.1	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1072.8	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1091.3	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1108.3	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1152.2	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1185.5	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1202.2	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1227.8	0.0	0.000	-1.964	1.000	0.000	-0.189	0
1237.2	254.6	-0.964	-2.928	-0.266	-0.266	-0.455	1
1239.3	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1239.4	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1239.7	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1240.4	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1240.7	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1240.9	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1241.2	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1241.4	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1241.6	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1241.7	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1242.1	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1242.3	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1242.4	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1242.5	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1242.8	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1243.8	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1243.9	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1244.9	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1245.3	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1245.6	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1247.2	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1247.3	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1247.5	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1247.6	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1247.7	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1247.8	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1248.3	0.0	0.000	-2.928	1.000	0.000	-0.455	0
1249.0	0.0	0.000	-2.928	1.000	0.000	-0.455	0

arithmetic mean of strike values (col 2) = 261.2 Total measurements taken = 3

Feature Orientation measurements Well: MIKWA RIVER 10-22-98-3W5 Semi-vertical Fractures
 Reference Mardia 1972 for statistics of directional data

Total Sin x thick	Total Cos x thick	Total Thickness	S Col A/Col C	C ColB/ColC	R x R	R	S/R	C/R	Azimuth from S/R	Azimuth from C/R	Standard Deviation
-2.928	-0.455	3	-0.9760	-0.1517	0.9756	0.9877	-0.9881	-0.1536	261.2	261.2	9.0

Well Name: Mobil MIKWA RIVER 10-22-98-3W5							
Natural Fractures							
Depth KB m	Azimuth of feature	Sin Azi	Cumulative Total Sin Azi	Cos Azi	Cos Azi corrected for zero values	Cumulative Total Cos Azi	Measurement made or not 1 or 0 entered
793.2	0	0.000	0.000	1.000	0.000	0.000	0
798.8	0	0.000	0.000	1.000	0.000	0.000	0
809.1	0	0.000	0.000	1.000	0.000	0.000	0
815.0	0	0.000	0.000	1.000	0.000	0.000	0
833.0	0	0.000	0.000	1.000	0.000	0.000	0
844.9	0	0.000	0.000	1.000	0.000	0.000	0
852.2	0	0.000	0.000	1.000	0.000	0.000	0
876.4	0	0.000	0.000	1.000	0.000	0.000	0
888.2	0	0.000	0.000	1.000	0.000	0.000	0
891.0	0	0.000	0.000	1.000	0.000	0.000	0
915.5	0	0.000	0.000	1.000	0.000	0.000	0
1005.7	0	0.000	0.000	1.000	0.000	0.000	0
1017.2	0	0.000	0.000	1.000	0.000	0.000	0
1018.1	224.9	-0.706	-0.706	-0.708	-0.708	-0.708	1
1027.9	0	0.000	-0.706	1.000	0.000	-0.708	0
1050.1	0	0.000	-0.706	1.000	0.000	-0.708	0
1072.8	0	0.000	-0.706	1.000	0.000	-0.708	0
1091.3	196.9	-0.291	-0.997	-0.957	-0.957	-1.665	1
1108.3	0	0.000	-0.997	1.000	0.000	-1.665	0
1152.2	0	0.000	-0.997	1.000	0.000	-1.665	0
1185.5	0	0.000	-0.997	1.000	0.000	-1.665	0
1202.2	212.8	-0.542	-1.538	-0.841	-0.841	-2.506	1
1227.8	0	0.000	-1.538	1.000	0.000	-2.506	0
1237.2	0	0.000	-1.538	1.000	0.000	-2.506	0
1239.3	259.7	-0.984	-2.522	-0.179	-0.179	-2.685	1
1239.4	0	0.000	-2.522	1.000	0.000	-2.685	0
1239.7	233.2	-0.801	-3.323	-0.599	-0.599	-3.284	1
1240.4	124.5	0.824	-2.499	-0.566	-0.566	-3.850	1
1240.7	109.2	0.944	-1.554	-0.329	-0.329	-4.179	1
1240.9	90.9	1.000	-0.555	-0.016	-0.016	-4.195	1
1241.2	0	0.000	-0.555	1.000	0.000	-4.195	0
1241.4	0	0.000	-0.555	1.000	0.000	-4.195	0
1241.6	0	0.000	-0.555	1.000	0.000	-4.195	0
1241.7	0	0.000	-0.555	1.000	0.000	-4.195	0
1242.1	0	0.000	-0.555	1.000	0.000	-4.195	0
1242.3	184.3	-0.075	-0.629	-0.997	-0.997	-5.192	1
1242.4	0	0.000	-0.629	1.000	0.000	-5.192	0
1242.5	167.9	0.210	-0.420	-0.978	-0.978	-6.169	1
1242.8	148.1	0.528	0.109	-0.849	-0.849	-7.018	1
1243.8	144.3	0.584	0.692	-0.812	-0.812	-7.831	1
1243.9	0	0.000	0.692	1.000	0.000	-7.831	0
1244.9	185.7	-0.099	0.593	-0.995	-0.995	-8.826	1
1245.3	177.8	0.038	0.631	-0.999	-0.999	-9.825	1
1245.6	0	0.000	0.631	1.000	0.000	-9.825	0
1247.2	0	0.000	0.631	1.000	0.000	-9.825	0
1247.3	171.2	0.153	0.784	-0.988	-0.988	-10.813	1
1247.5	0	0.000	0.784	1.000	0.000	-10.813	0
1247.6	182.0	-0.035	0.749	-0.999	-0.999	-11.812	1
1247.7	170.9	0.158	0.907	-0.987	-0.987	-12.800	1
1247.8	170.9	0.158	1.066	-0.987	-0.987	-13.787	1
1248.3	171.3	0.151	1.217	-0.988	-0.988	-14.776	1
1249.0	0	0.000	1.217	1.000	0.000	-14.776	0

arithmetic mean of strike values (col 2) = 175.1 Total measurements taken = 19

Feature Orientation measurements
Reference Mardia 1972 for statistics of directional data

Well: MIKWA RIVER 10-22-98-3W5 Natural Fractures

Total Sin x thick	Total Cos x thick	Total Thickness	S Col A/Col C	C Col B/Col C	R x R	R	S/R	C/R	Azimuth from S/R	Azimuth from C/R	Standard Deviation
1.217	-14.776	19	0.0641	-0.7777	0.6089	0.7803	0.0821	-0.9966	175.3	184.7	40.4

Well Name: Mobil MIKWA RIVER 10-22-98-3W5							
Incipient Breakouts							
Depth KB m	Azimuth of feature	Sin Azi	Cumulative Total Sin Azi	Cos Azi	Cos Azi corrected for zero values	Cumulative Total Cos Azi	Measurement made or not 1 or 0 entered
793.2	0.0	0.000	0.000	1.000	0.000	0.000	0
798.8	0.0	0.000	0.000	1.000	0.000	0.000	0
809.1	0.0	0.000	0.000	1.000	0.000	0.000	0
815.0	0.0	0.000	0.000	1.000	0.000	0.000	0
833.0	0.0	0.000	0.000	1.000	0.000	0.000	0
844.9	0.0	0.000	0.000	1.000	0.000	0.000	0
852.2	0.0	0.000	0.000	1.000	0.000	0.000	0
876.4	135.0	0.707	0.707	-0.707	-0.707	-0.707	1
888.2	0.0	0.000	0.707	1.000	0.000	-0.707	0
891.0	0.0	0.000	0.707	1.000	0.000	-0.707	0
915.5	0.0	0.000	0.707	1.000	0.000	-0.707	0
1005.7	165.0	0.259	0.966	-0.966	-0.966	-1.673	1
1017.2	0.0	0.000	0.966	1.000	0.000	-1.673	0
1018.1	0.0	0.000	0.966	1.000	0.000	-1.673	0
1027.9	0.0	0.000	0.966	1.000	0.000	-1.673	0
1050.1	0.0	0.000	0.966	1.000	0.000	-1.673	0
1072.8	0.0	0.000	0.966	1.000	0.000	-1.673	0
1091.3	0.0	0.000	0.966	1.000	0.000	-1.673	0
1108.3	0.0	0.000	0.966	1.000	0.000	-1.673	0
1152.2	0.0	0.000	0.966	1.000	0.000	-1.673	0
1185.5	0.0	0.000	0.966	1.000	0.000	-1.673	0
1202.2	0.0	0.000	0.966	1.000	0.000	-1.673	0
1227.8	0.0	0.000	0.966	1.000	0.000	-1.673	0
1237.2	0.0	0.000	0.966	1.000	0.000	-1.673	0
1239.3	0.0	0.000	0.966	1.000	0.000	-1.673	0
1239.4	0.0	0.000	0.966	1.000	0.000	-1.673	0
1239.7	0.0	0.000	0.966	1.000	0.000	-1.673	0
1240.4	0.0	0.000	0.966	1.000	0.000	-1.673	0
1240.7	0.0	0.000	0.966	1.000	0.000	-1.673	0
1240.9	0.0	0.000	0.966	1.000	0.000	-1.673	0
1241.2	0.0	0.000	0.966	1.000	0.000	-1.673	0
1241.4	0.0	0.000	0.966	1.000	0.000	-1.673	0
1241.6	0.0	0.000	0.966	1.000	0.000	-1.673	0
1241.7	0.0	0.000	0.966	1.000	0.000	-1.673	0
1242.1	0.0	0.000	0.966	1.000	0.000	-1.673	0
1242.3	0.0	0.000	0.966	1.000	0.000	-1.673	0
1242.4	0.0	0.000	0.966	1.000	0.000	-1.673	0
1242.5	0.0	0.000	0.966	1.000	0.000	-1.673	0
1242.8	0.0	0.000	0.966	1.000	0.000	-1.673	0
1243.8	0.0	0.000	0.966	1.000	0.000	-1.673	0
1243.9	0.0	0.000	0.966	1.000	0.000	-1.673	0
1244.9	0.0	0.000	0.966	1.000	0.000	-1.673	0
1245.3	0.0	0.000	0.966	1.000	0.000	-1.673	0
1245.6	0.0	0.000	0.966	1.000	0.000	-1.673	0
1247.2	0.0	0.000	0.966	1.000	0.000	-1.673	0
1247.3	0.0	0.000	0.966	1.000	0.000	-1.673	0
1247.5	0.0	0.000	0.966	1.000	0.000	-1.673	0
1247.6	0.0	0.000	0.966	1.000	0.000	-1.673	0
1247.7	0.0	0.000	0.966	1.000	0.000	-1.673	0
1247.8	0.0	0.000	0.966	1.000	0.000	-1.673	0
1248.3	0.0	0.000	0.966	1.000	0.000	-1.673	0
1249.0	0.0	0.000	0.966	1.000	0.000	-1.673	0

arithmetic mean of strike values (col 2) = 150.0 Total measurements taken = 2

Feature Orientation measurements
Reference Mardia 1972 for statistics
of directional data.

Well: MIKWA RIVER 10-22-98-3W5 **Incipient Breakouts**

Total Sin x thick	Total Cos x thick	Total Thickness	S Col A/Col C	C Col B/Col C	R x R	R	S/R	C/R	Azimuth from S/R	Azimuth from C/R	Standard Deviation
0.966	-1.673	2	0.4830	-0.8365	0.9330	0.9659	0.5000	-0.8660	150.0	210.0	15.1

Well Name: Mobil MIKWA RIVER 10-22-98-3W5							
Bedding							
Depth KB m	Azimuth of feature	Sin Azi	Cumulative Total Sin Azi	Cos Azi	Cos Azi corrected for zero values	Cumulative Total Cos Azi	Measurement made or not 1 or 0 entered
793.2	185.6	-0.098	-0.098	-0.995	-0.995	-0.995	1
798.8	143.2	0.599	0.501	-0.801	-0.801	-1.796	1
809.1	182.3	-0.040	0.461	-0.999	-0.999	-2.795	1
815.0	261.4	-0.989	-0.527	-0.150	-0.150	-2.945	1
833.0	0.0	0.000	-0.527	1.000	0.000	-2.945	0
844.9	90.2	1.000	0.473	-0.003	-0.003	-2.948	1
852.2	203.8	-0.404	0.069	-0.915	-0.915	-3.863	1
876.4	0.0	0.000	0.069	1.000	0.000	-3.863	0
888.2	0.0	0.000	0.069	1.000	0.000	-3.863	0
891.0	159.9	0.344	0.413	-0.939	-0.939	-4.802	1
915.5	155.0	0.423	0.835	-0.906	-0.906	-5.709	1
1005.7	0.0	0.000	0.835	1.000	0.000	-5.709	0
1017.2	0.0	0.000	0.835	1.000	0.000	-5.709	0
1018.1	0.0	0.000	0.835	1.000	0.000	-5.709	0
1027.9	111.5	0.930	1.766	-0.367	-0.367	-6.075	1
1050.1	208.6	-0.479	1.287	-0.878	-0.878	-6.953	1
1072.8	259.0	-0.982	0.305	-0.191	-0.191	-7.144	1
1091.3	0.0	0.000	0.305	1.000	0.000	-7.144	0
1108.3	102.9	0.975	1.280	-0.223	-0.223	-7.367	1
1152.2	253.2	-0.957	0.323	-0.289	-0.289	-7.656	1
1185.5	203.8	-0.404	-0.081	-0.915	-0.915	-8.571	1
1202.2	0.0	0.000	-0.081	1.000	0.000	-8.571	0
1227.8	194.2	-0.245	-0.326	-0.969	-0.969	-9.541	1
1237.2	0.0	0.000	-0.326	1.000	0.000	-9.541	0
1239.3	0.0	0.000	-0.326	1.000	0.000	-9.541	0
1239.4	216.9	-0.600	-0.926	-0.800	-0.800	-10.340	1
1239.7	0.0	0.000	-0.926	1.000	0.000	-10.340	0
1240.4	0.0	0.000	-0.926	1.000	0.000	-10.340	0
1240.7	0.0	0.000	-0.926	1.000	0.000	-10.340	0
1240.9	0.0	0.000	-0.926	1.000	0.000	-10.340	0
1241.2	222.8	-0.679	-1.606	-0.734	-0.734	-11.074	1
1241.4	129.8	0.768	-0.838	-0.640	-0.640	-11.714	1
1241.6	268.9	-1.000	-1.837	-0.019	-0.019	-11.733	1
1241.7	135.1	0.706	-1.132	-0.708	-0.708	-12.442	1
1242.1	188.1	-0.141	-1.272	-0.990	-0.990	-13.432	1
1242.3	0.0	0.000	-1.272	1.000	0.000	-13.432	0
1242.4	248.8	-0.932	-2.205	-0.362	-0.362	-13.793	1
1242.5	0.0	0.000	-2.205	1.000	0.000	-13.793	0
1242.8	0.0	0.000	-2.205	1.000	0.000	-13.793	0
1243.8	0.0	0.000	-2.205	1.000	0.000	-13.793	0
1243.9	153.4	0.448	-1.757	-0.894	-0.894	-14.687	1
1244.9	0.0	0.000	-1.757	1.000	0.000	-14.687	0
1245.3	0.0	0.000	-1.757	1.000	0.000	-14.687	0
1245.6	139.0	0.656	-1.101	-0.755	-0.755	-15.442	1
1247.2	180.3	-0.005	-1.106	-1.000	-1.000	-16.442	1
1247.3	0.0	0.000	-1.106	1.000	0.000	-16.442	0
1247.5	184.5	-0.078	-1.185	-0.997	-0.997	-17.439	1
1247.6	0.0	0.000	-1.185	1.000	0.000	-17.439	0
1247.7	0.0	0.000	-1.185	1.000	0.000	-17.439	0
1247.8	0.0	0.000	-1.185	1.000	0.000	-17.439	0
1248.3	0.0	0.000	-1.185	1.000	0.000	-17.439	0
1249.0	197.0	-0.292	-1.477	-0.956	-0.956	-18.395	1

arithmetic mean of strike values (col 2) = 184.4 Total measurements taken = 27

Feature Orientation measurements
Reference Mardia 1972 for statistics of directional data

Well: MIKWA RIVER 10-22-98-3W5 Bedding

Total Sin x thick	Total Cos x thick	Total Thickness	S Col A/Col C	C Col B/Col C	R x R	R	S/R	C/R	Azimuth from S/R	Azimuth from C/R	Standard Deviation
-1.477	-18.395	27	-0.0547	-0.6813	0.4672	0.6835	-0.0800	-0.9968	184.6	184.6	50.0