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Forsmark site investigation

Analysis of uncertainty and changes in orientation of fractures coupled to PFL anomalies

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September 2007

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Abstract

This report concerns the orientation uncertainty of fractures that are identified to be flowing by using the Posiva Flow Log in the twelve cored boreholes KFM01A, -01D, -02A, -03A, -04A, -05A, -06A, -07A, -07C, -08A, -08C and -10A. Reported is the difference between fracture orientation data stored in Sicada December 17, 2006 and the data stored June 5, 2007 together with the sample space for the orientation uncertainty of the fractures. The maximum uncertainty is expressed as the dihedral angle, Ω, and the sample space of uncertainty as an area projected on the lower hemisphere.

The changes of orientation are small for most fractures, 88% of the 251 studied, have a change smaller than 10° while 50% have a change smaller than 1°. The largest corrections are made in the boreholes KFM01A, -02A and -03A.

Of the 251 studied fractures 120 have a maximum uncertainty, Ω, larger than 10° and ten of them a maximum uncertainty larger than 30°. Twelve fractures have a change in orientation larger than the maximum uncertainty and consequently the orientation data stored in Sicada December 17, 2006 is not valid as a possible orientation within the data stored June 5, 2007.

Sammanfattning

Denna rapport berör osäkerhet i orientering hos sprickor som är förknippade med flöden mätta med Posiva Flow Log i borrhålen KFM01A, -01D, -02A, -03A, -04A, -05A, -06A, -07A, -07C, -08A, -08C and -10A. Rapporten visar skillnaderna mellan sprickorinteringsdata lagrade i Sicada 2006-12-17 och data lagrade 2007-06-05 samt utfallsrummet för orienteringsosäkerheten. Den största osäkerheten är uttryckt som rymdvinkeln, Ω, medan utfallsrummet av osäkerheten är en yta projicerad på den undre hemisfären.

Korrektionen av sprickornas orientering är liten för de flesta sprickorna, 88 % av de 251 studerade har en ändring i orientering mindre än 10° medan 50 % har ändrats mindre än 1°. De största korrektionerna har gjorts i borrhålen KFM01A, -02A och -03A.

Av de 251 studerade sprickorna har 120 en maximal osäkerhet, Ω, som är större än 10° och för tio av dem är osäkerheten större än 30°. Tolv sprickor har en ändring i orientering som överstiger den maximala osäkerheten och således är orienteringsdata från 2006-12-17 utanför utfallsrummet för data från 2007-06-05, vilket innebär att den gamla orienteringen ligger utanför en möjlig orientering.

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1 Introduction

During the period September 2006 to March 2007, an extensive work has been carried out to correct the orientation of boreholes and the data mapped in them. The result of that work is that fracture orientation measurements have been altered and that it is now possible to calculate a sample space for the uncertainty of the fracture orientation, see /Munier and Stigsson 2007/.

The work reported here is limited to treat the 251 fractures out of a total of 577 fractures that have been identified as flowing using the Posiva Flow Log /Follin et al. 2007, Forsman et al. 2004, 2006 and Teurneau et al. 2007/. The 251 fractures all occur outside deformation zones modelled by /Stephens et al. 2007/, i.e. they are recognized as single fractures that within the fracture domains /Olofsson et al. 2007/. Data for the 251 fractures are listed in Appendix A.

The work consists of three parts:

1. Connecting the corresponding Feature ID to each fracture in Sicada dated before December 17, 2006.
2. Calculating the differences in fracture orientation between the data in Sicada December 17, 2006 and June 5, 2007.
3. Calculating the sample space for the uncertainty of fracture orientation of the June 5, 2007 data.

The results from this report are intended to be used as a support when analysing and modelling flow in discrete fracture networks using Forsmark stage 2.2 data.

1.1 Nomenclature and definitions

Alpha angle is the angle between the fracture plane and the axis of the borehole, i.e. a fracture parallel to the borehole has alpha = 0° and a fracture perpendicular to the borehole has alpha = 90°.

Beta angle is the angle between the reference line in the Bips image and the lower extreme in the direction of the borehole. It is measured from 0° to 360° clockwise.

Current data are found in the tables "p_fract_core" and "object_location" stored in Sicada June 5 2007, /Sicada 2007/.

Dihedral angle is the angle between two vectors in 3D space, see e.g. /Munier and Stigsson 2007/.

Maximum uncertainty, **Ω**, the maximum dihedral angle from the best estimate of the fracture orientation to the point in the sample space that is furthest away, maximum possible value is 90º, /see Munier and Stigsson 2007/ for details.

PFL fractures are flowing fractures as determined with the Posiva Flow Log. The geometrical interpretations, location and orientation, of the PFL fractures are reported in /Forsman et al. 2004, 2006 and Teurneau et al. 2007/.

Pre 2007 data refer to the orientation data in Sicada stored December 17, 2006. This is the information used for Hydro-DFN modelling by /Follin et al. 2007/.

2 Coupling Feature ID to pre 2007 data

Prior to March 2007 fractures in Sicada tables were not assigned a unique identifier, Feature ID, which is a prerequisite to do further comparisons and investigations. The pre 2007 data used by /Follin et al. 2007/ in the Hydrogelogical DFN modelling were filtered and only consisted of the following nine parameters:

- FRACT_MAPPED
- FRACT_INTERPRET
- CONFIDENCE
- APERTURE
- ALPHA
- SECUP
- STRIKE
- DIP
- ELEVATION

Only the first six parameters in the list above can be used as identifiers. The elevation can not be used since the definition of the location of the boreholes has changed during the update of the fracture orientation, /see Munier and Stigsson 2007/. However there has not been any changes to the alpha angle and hence this parameter can be used as an identifier as well.

The coupling between pre 2007 data and current data is done using VBA-macro in Excel 2003, see Appendix 2. Briefly the algorithm uses the SECUP parameter and identifies all fractures within ± 1 cm. In 217 cases of 251 only one fracture exists within this interval, but to be sure that the data represent the same fracture the other five parameters are compared. If four of the five parameters is equal the data are assumed to represent the same fracture and the PFL fracture is assigned the Feature ID from the current p_fract_core, /Sicada 2007/.

For 204 fractures of the 217 the matches are perfect. For the remaining 13 fractures eight differ in aperture, one differs in confidence and the last four differ in the fracture interpretation, open, partly open or sealed, see Table 2-1.

Among the remaining 34 cases (251–217), that contains more than one alternative fracture, the same procedure is carried out and the fracture with most equal parameters are assumed to be the same feature. For 32 cases there is a perfect match between the pre 2007 data and the current data in table p_fract_core, /Sicada 2007/. For the remaining two fractures there is one with difference in alpha angle and one differs in aperture, see Table 2-1.

Table 2-1. The fractures where the match was not perfect or were multiple choices of fractures was possible.

Idcode	PFL-NO	FEATURE_ID	Difference between data sets	Multiple possible fractures
KFM01D	4	EC5142D98F11DF5F	–	Multiple
KFM01D	9	F29142D98F11F42C	–	Multiple
KFM01D	11	FC1142D98F12008F	–	Multiple
KFM01D	19	A11142D98F1250F4	Confidence	–
KFM01D	22	F29142D98F12669A	–	Multiple
KFM01D	26	1D5142D98F14AE5F	–	Multiple
KFM01D	28	355142D98F15609F	–	Multiple
KFM01D	29	631142D98F1567D1	–	Multiple
KFM01D	34	099142D98F18AFFF	–	Multiple
KFM02A	101	B81242D98A371364	–	Multiple
KFM03A	32	3AD342D98A263D27	Alpha	Multiple
KFM03A	33	589342D98A263FE5	–	Multiple
KFM03A	39	60D342D98A27D5E0	–	Multiple
KFM03A	41	6F9342D98A281A35	–	Multiple
KFM04A	37	155442D98A62B205	–	Multiple
KFM04A	38	811442D98A62B442	Aperture	–
KFM04A	39	23D442D98A62B8F9	Aperture	–
KFM04A	40	0C1442D98A62BD21	Aperture	–
KFM04A	41	149442D98A62C4A1	Aperture	–
KFM04A	42	101442D98A62D63E	Aperture	Multiple
KFM04A	43	341442D98A62D8B3	Aperture	–
KFM04A	44	335442D98A62E743	Aperture	–
KFM04A	45	2B5442D98A62E9CC	–	Multiple
KFM04A	46	A31442D98A62EBF9	Aperture	–
KFM04A	47	60D442D98A62F185	Aperture	–
KFM04A	48	E79442D98A62F80D	–	Multiple
KFM05A	8	179542D98A11C700	–	Multiple
KFM05A	11	43D542D98A11D6F9	–	Multiple
KFM05A	25	0AD542D98A14068F	–	Multiple
KFM06A	6	339642D98A31BB74	–	Multiple
KFM06A	30	E35642D98A32395B	–	Multiple
KFM06A	44	53D642D98A32A264	O/PO/S	–
KFM06A	75	945642D98A3485D4	–	Multiple
KFM06A	76	C3D642D98A349C05	O/PO/S	–
KFM06A	93	AD1642D98A35F8ED	O/PO/S	–
KFM07A	24	565742D98A2DEE01	–	Multiple
KFM07A	25	8E9742D98A2DEF3C	–	Multiple
KFM08A	10	705842D98A22A57B	–	Multiple
KFM08A	20	F45842D98A230332	–	Multiple
KFM08A	22	CB9842D98A231337	–	Multiple
KFM08A	24	655842D98A23AE78	–	Multiple
KFM08A	34	C4D842D98A2648FD	–	Multiple
KFM08A	36	10D842D98A26E05F	–	Multiple
KFM08C	1	695842D988218F94	O/PO/S	–
KFM08C	6	9F5842D988236F27	–	Multiple
KFM10A	40	21D046D98A14FEFE	–	Multiple
KFM10A	44	BAD046D98A151AEC	–	Multiple

3 Change in orientation of fractures

The input parameters for the calculation of the orientation of a fracture are the bearing and inclination of the borehole together with the alpha and beta angles of the fracture plane mapped on the core. For a further information regarding the equations of how the orientation is calculated /see e.g. Munier and Stigsson 2007/. The changes in orientation of the boreholes are minor, usually less than a couple of degrees, and the alpha angle is not changed during the revision of the data. Hence the major change in orientation is the change in the beta angle due to correction of the Bips image. Consequently the change of orientation of a fracture measured in a vertical hole only will affect the strike.

The absolute difference in strike between the pre 2007 and the current data as a function of the current dip is shown in Figure 3-1. The figure shows that the largest differences occur in the three oldest boreholes; KFM01A, -2A and -3A. Most fractures affected by a large change in strike are sub horizontal. However, there is a small amount of steep fractures having a large difference in strike, i.e. the correction of the orientation is large. The eleven fractures with dip larger than 75° and strike difference larger than 20° are listed in Table 3-1.

A better way of analyzing the changes in orientation is to use the dihedral angle between the two pole vectors of the fracture plane. The fractures with the largest dihedral angle is the very same as listed in Table 3-1. Some of these fractures should be paid extra attention since the change in orientation is larger than the sample space of uncertainty, implying that the pre 2007 orientation is not valid for them, see further Section 4.1.

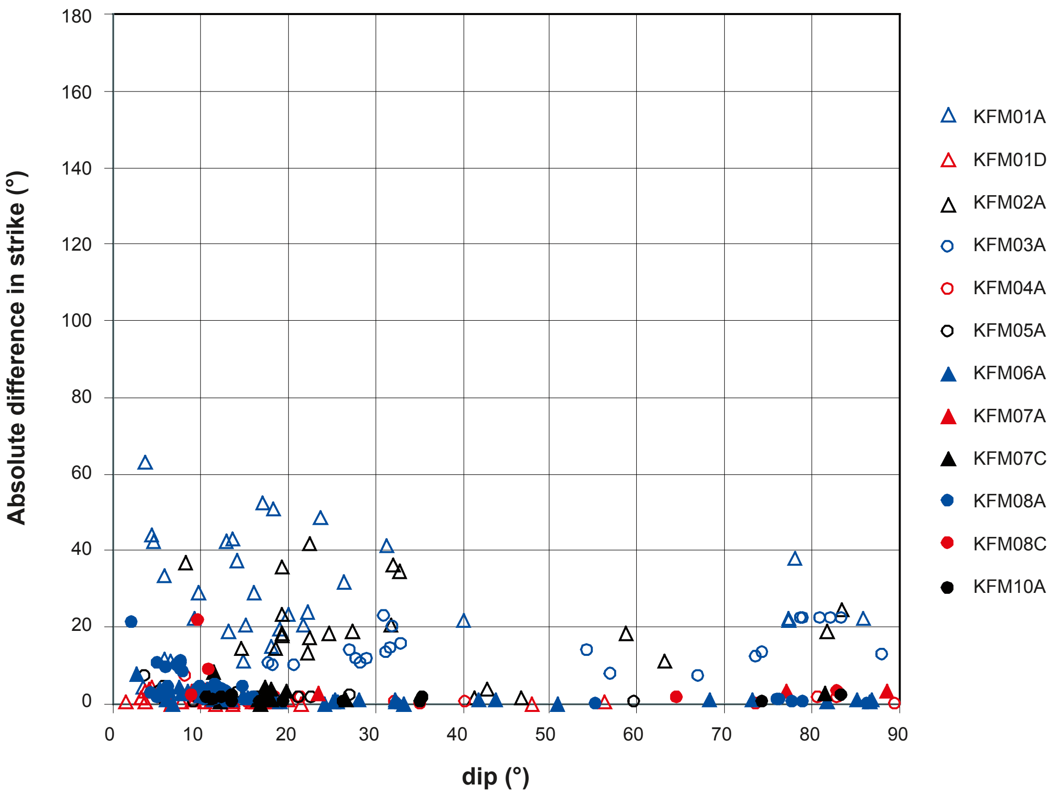


Figure 3-1. *Difference in strike as a function of dip divided on different boreholes.*

Table 3-1. The Feature ID of the 11 PFL fractures with the largest difference in strike and largest dihedral angle between fracture plane poles.

Borehole name	Fracture feature ID	Dip (°)	Strike diff (°)	Dihedral angle (°)
KFM01A	951142D98A21F490	78	38.2	37.3
KFM02A	26D242D98A335724	83.3	24.8	24.6
KFM03A	D19342D98A2EFA56	83.4	22.6	22.5
KFM03A	F29342D98A2F1783	82.2	22.6	22.4
KFM03A	AE5342D98A2EFA28	81	22.6	22.3
KFM03A	171342D98A2F1339	79.1	22.6	22.2
KFM03A	BA9342D98A2F175F	78.7	22.6	22.1
KFM01A	C41142D98A240A9E	85.9	22.1	22
KFM01A	AF5142D98A223BCF	77.4	22.2	21.6
KFM01A	AB5142D98A224585	77.3	21.8	21.3
KFM01A	911142D98A22A8A1	77.4	21.7	21.2

The Cumulative Density Function, CDF, for change in orientation of the 251 fractures is shown in Figure 3-2. As can be seen 88% of the fractures have a change in orientation that is less than 10°, and 50% of the fractures have a change in orientation less than 1°.

In Figure 3-3 to 3-14 is displayed the information in Figure 3-2 classified by borehole. The stereonets is complemented with CDF plots of the dihedral angle. The filled blue circles represent the current orientation whereas the open rings denote the pre 2007 orientations. The red lines couple the old orientation to the new of each single fracture and thereby enabling the possibility to see each individual change of orientation.

The largest corrections in orientation are made in the 3 first drilled boreholes, KFM01A, KFM02A and KFM03A, this is due to the holes being steep and at the time using poor technique for orienting the Bips image. None of the other holes has a change increasing 10°.

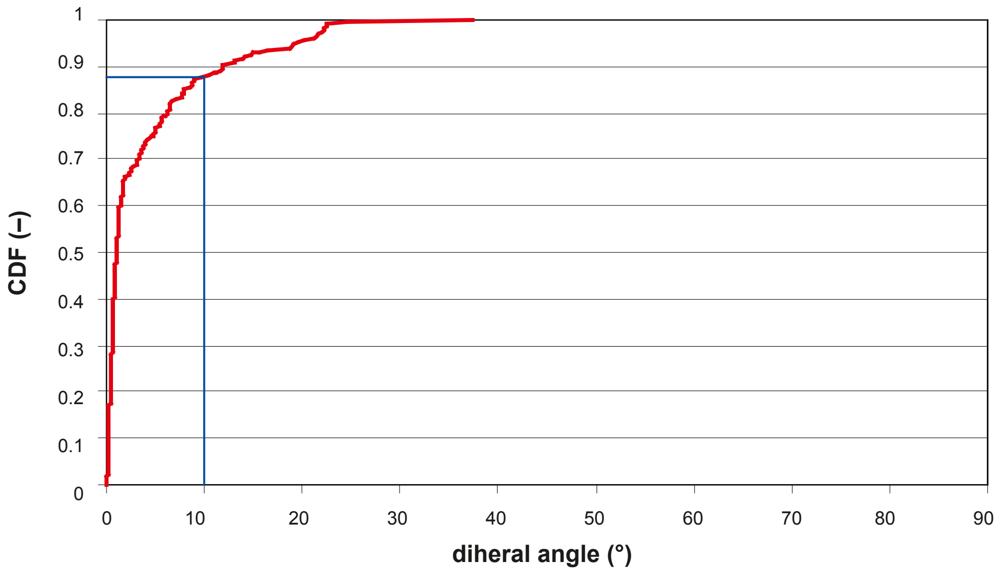


Figure 3-2. The cumulative density function, CDF, of the change in orientation of the 251 PFL fractures, i.e. the fractures that are interpreted to host the measured water flow using Posiva Flow Log.

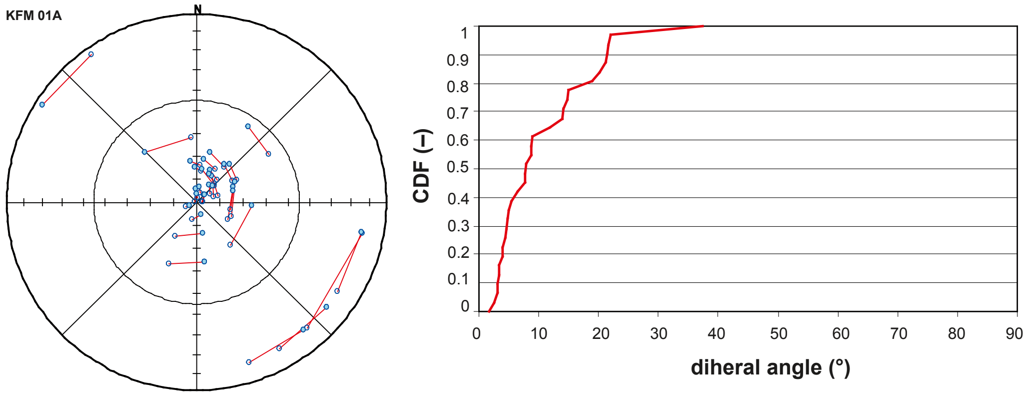


***Figure 3-3.** Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM01A.*

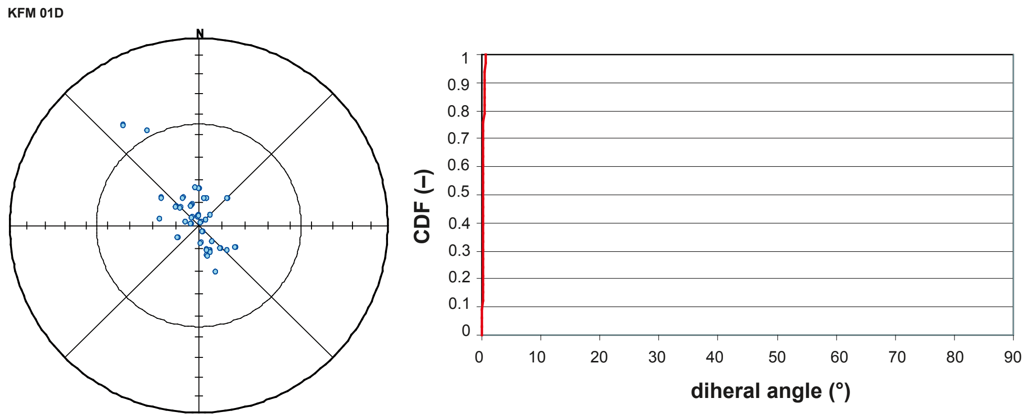


***Figure 3-4.** Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM01D.*

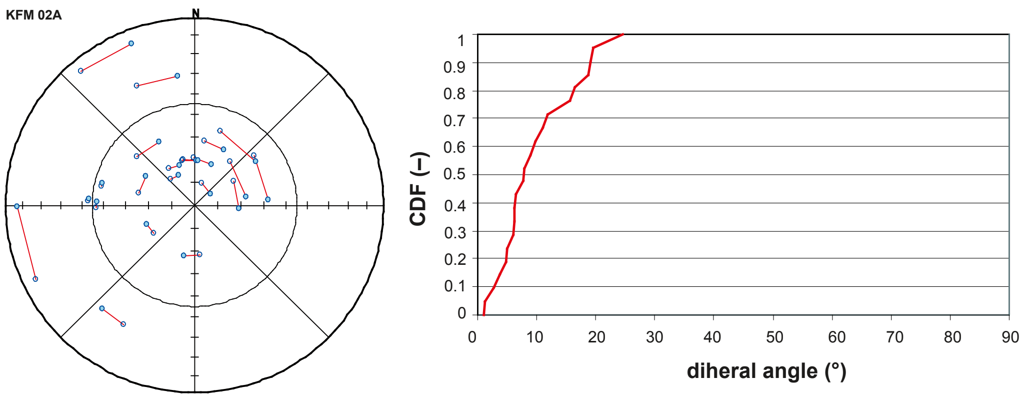


***Figure 3-5.** Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM02A.*

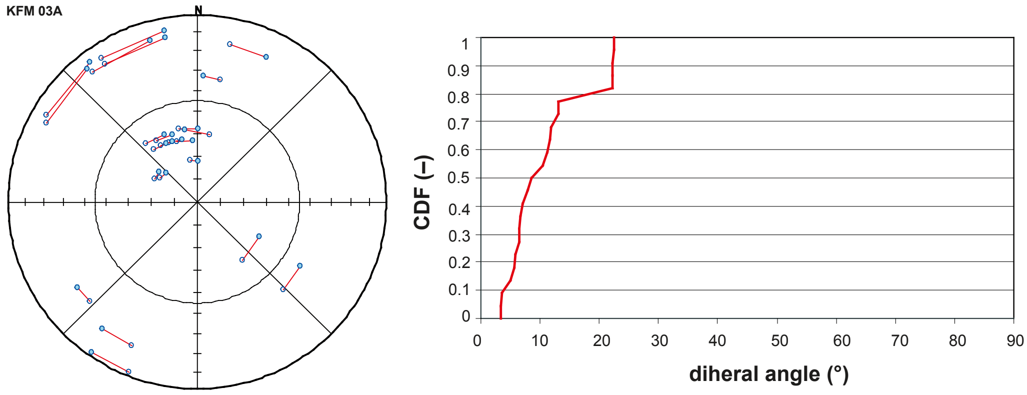


Figure 3-6. *Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM03A.*

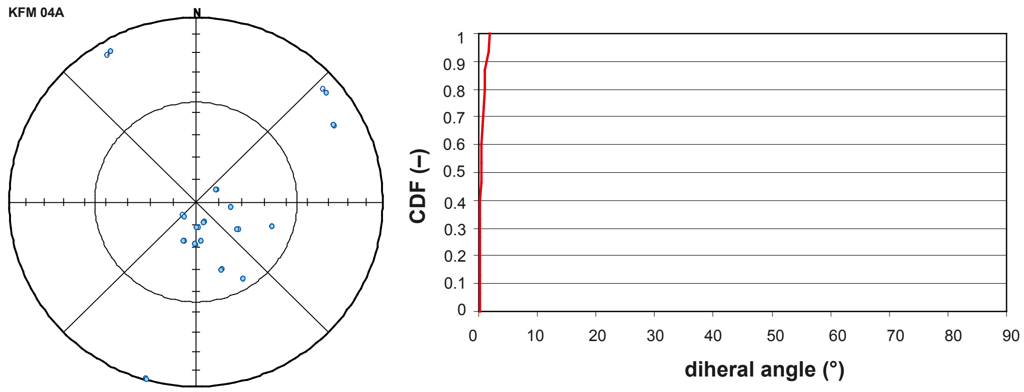


Figure 3-7. *Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM04A.*

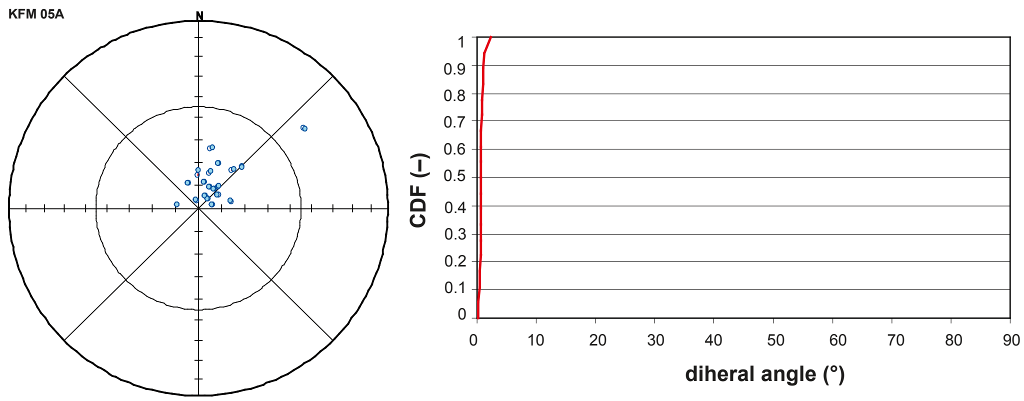


Figure 3-8. *Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM05A.*

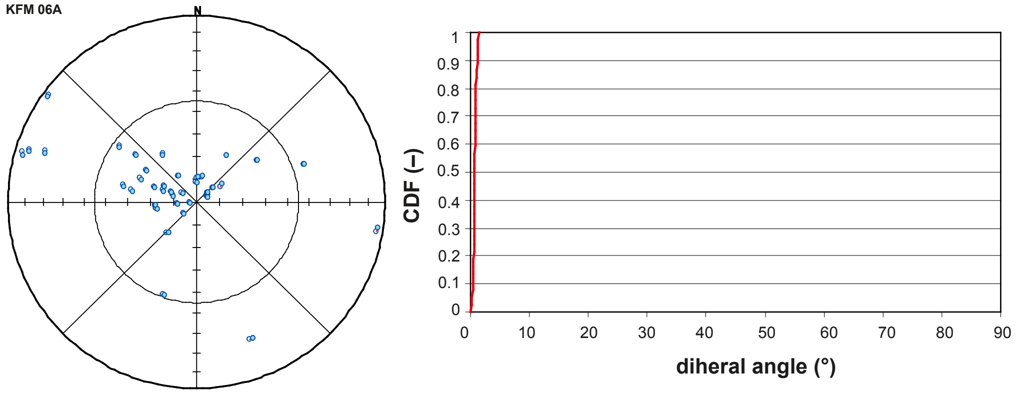


Figure 3-9. *Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM06A.*

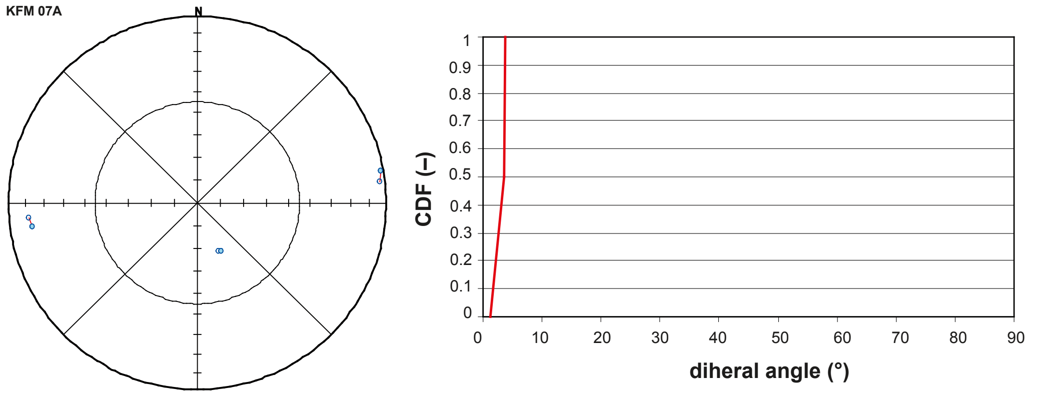


Figure 3-10. *Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM07A.*

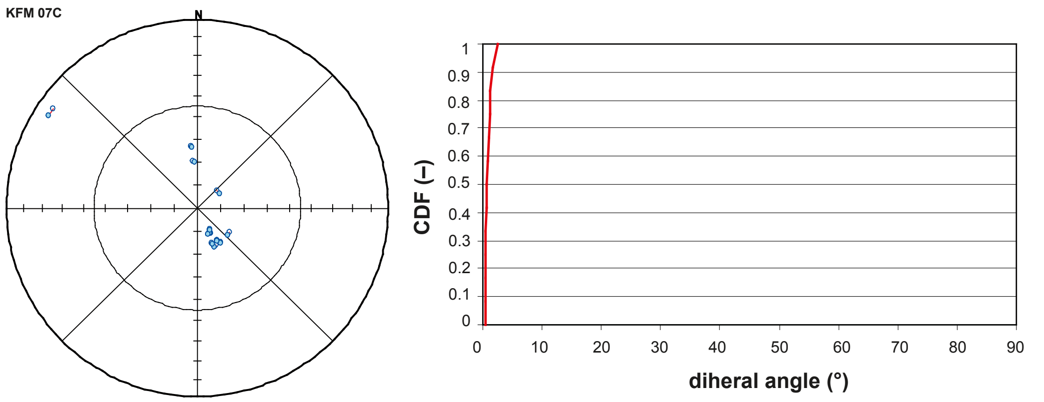


Figure 3-11. *Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM07C.*

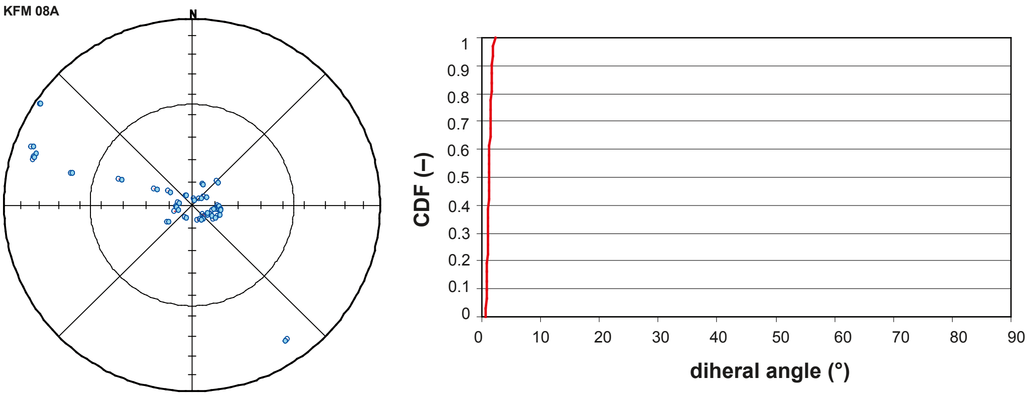


Figure 3-12. Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM08A.

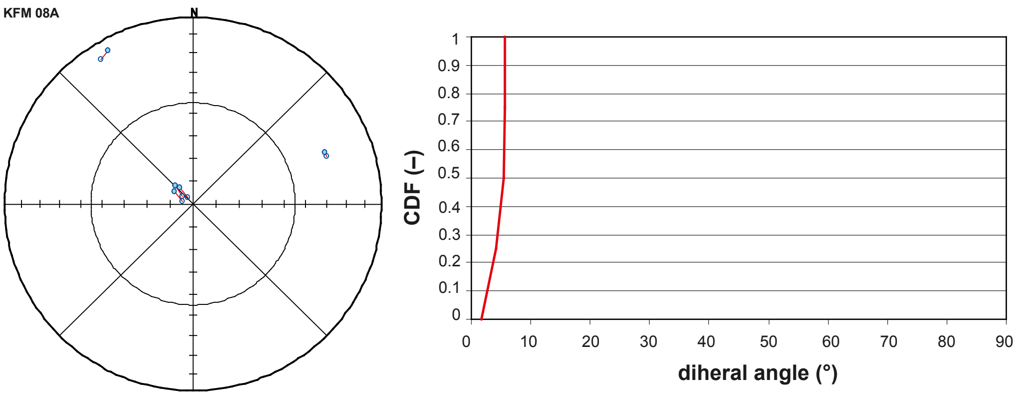


Figure 3-13. Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM08C.

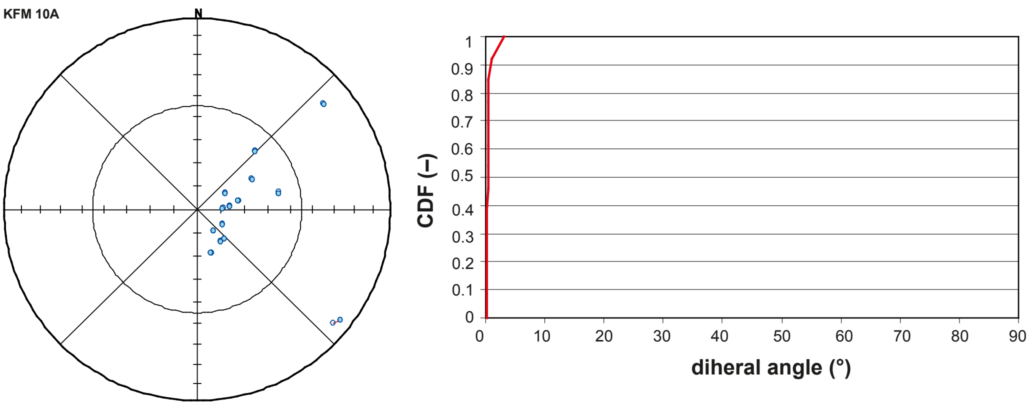


Figure 3-14. Equal area projection and cumulative density function of change in orientation between pre 2007 data and current data in KFM10A.

4 Uncertainty in orientation

The total uncertainty in fracture orientation is a compound effect of many interacting factors, e.g. the uncertainty in the orientation of the borehole, uncertainty during the core mapping, uncertainty in orientating of the Bips image, etc. For algorithms of how the uncertainty is calculated within the Sicada database /see Munier and Stigsson 2007/.

4.1 Sample space for each PFL fracture

The sample space for each fracture in each borehole is shown in Section 4.1.1 to 4.1.12. All stereonets are lower hemisphere equal area projection. The upper left stereonet is the uppermost PFL fracture in the core and the lower right corresponds to the last fracture.

Brown circles show the orientation of the borehole at the depth of the fracture. Filled blue circles are the best estimate of current orientation of the fracture and open blue circles are the pre 2007 orientation. The red area shows the sample space for the current orientation of the fracture. Each stereonet is marked with the Feature ID of the fracture.

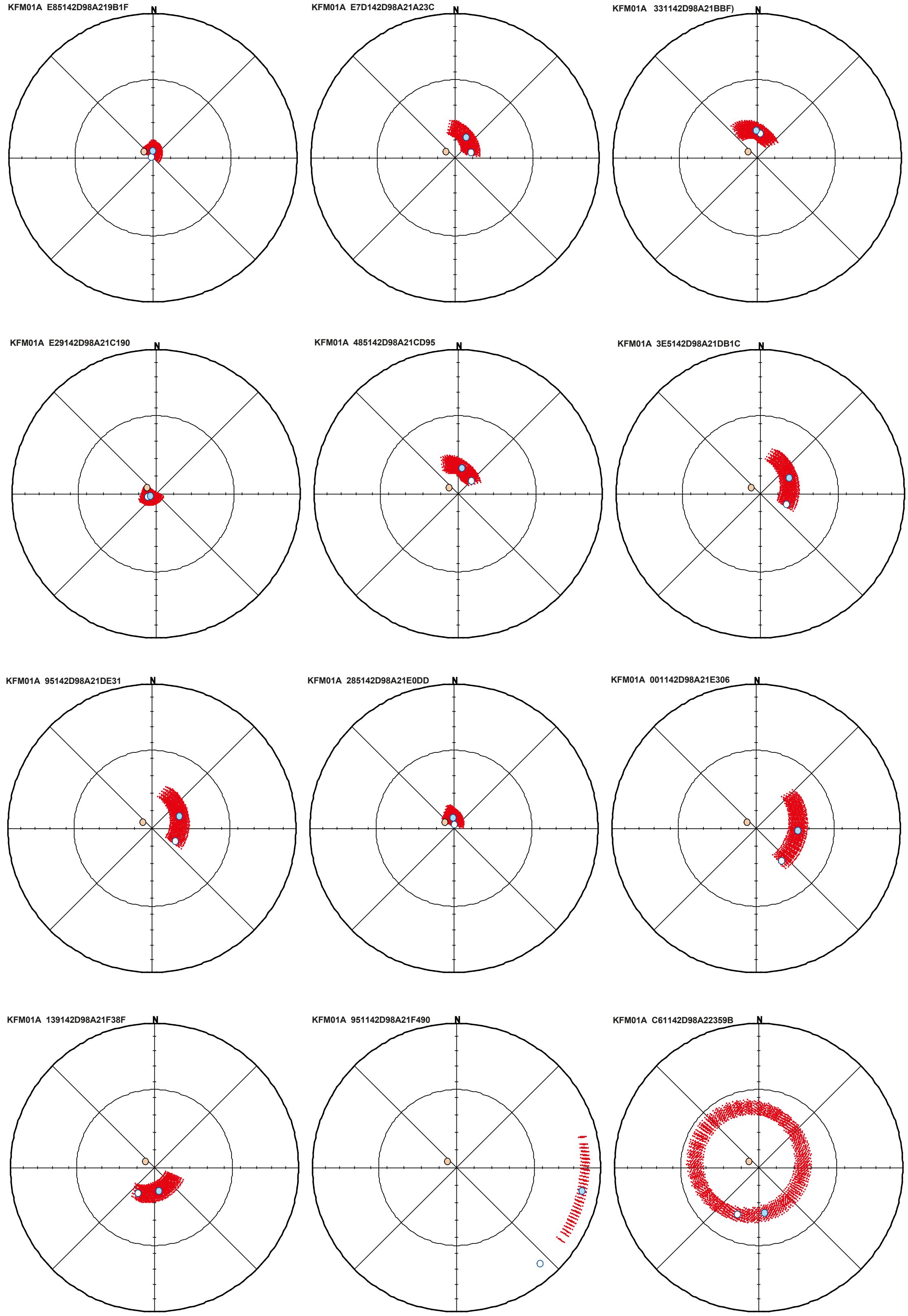
4.1.1 KFM01A

Below follow the sample space of uncertainty for the 32 PFL fractures in KFM01A. Extra attention should be paid to the 25 fractures listed in Table 4-1. These fractures have either a uncertainty, Ω, larger than 10°, or such a change in orientation that the pre 2007 orientation is outside the sample space of the current uncertainty, i.e. the pre 2007 orientation is not valid on the 90^{th} percentile. The fractures having large uncertainty can have an alternative interpretation of orientation compared to the best estimate orientation that is found in the table p_fract_core in /Sicada 2007/.

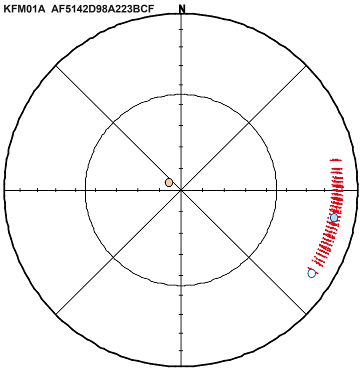
Table 4-1. Fractures in KFM01A needing extra attention.

Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
E7D142D98A21A23C	X		13.1	8.7
331142D98A21BBF9	X		13.9	3.0
485142D98A21CD95	X		13.2	8.7
3E5142D98A21DB1C	X		18.7	14.7
945142D98A21DE31	X		18.4	14.1
001142D98A21E306	X		22.5	19.0
139142D98A21F38F	X		15.3	11.7
951142D98A21F490	X	X	24.0	37.3
C61142D98A22359B	X		66.3	15.0
AF5142D98A223BCF	X	X	21.0	21.6
01D142D98A223F9E	X		14.2	5.5
AB5142D98A224585	X	X	21.0	21.3
5D5142D98A226A0C	X		16.6	7.9
681142D98A22779E	X		14.1	13.9
7E5142D98A227B60	X		14.5	6.4
911142D98A22A8A1	X	X	17.1	21.2
485142D98A22DBCD	X		15.6	7.7
E85142D98A237410	X	X	19.1	20.2
C41142D98A240A9E	X	X	20.8	22.0
311142D98A247332	X		16.9	8.9
239142D98A24AA7E	X		10.6	3.9
931142D98A24D08B	X		17.7	7.6

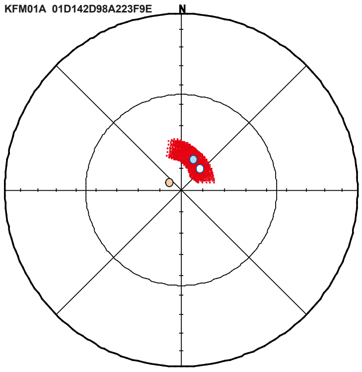
CA1142D98A24F44E	X	12.4	4.6
3B5142D98A250F64	X	12.7	4.8
099142D98A2585BD	X	11.7	4.9



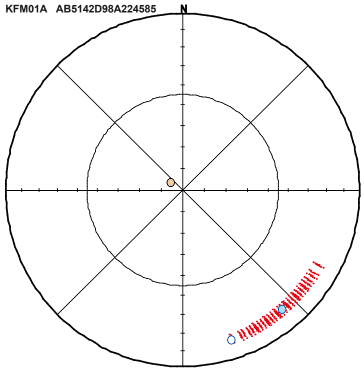
KFM01A AF5142D98A223BCF



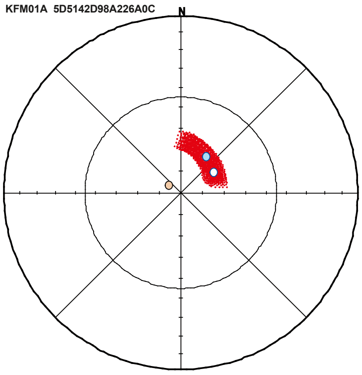
KFM01A 01D142D98A223F9E



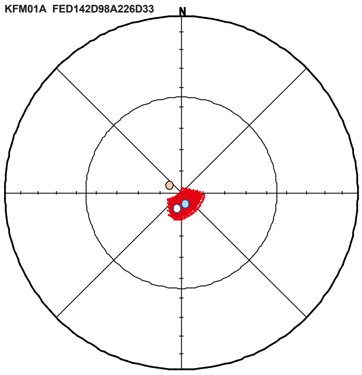
KFM01A AB5142D98A224585



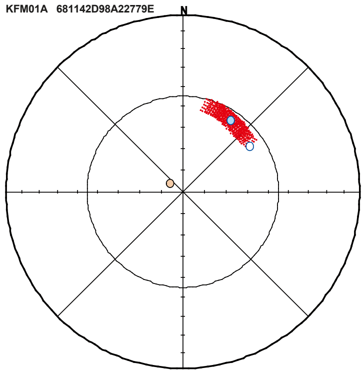
KFM01A 5D5142D98A226A0C



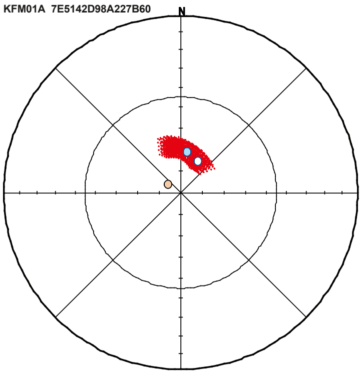
KFM01A FED142D98A226D33



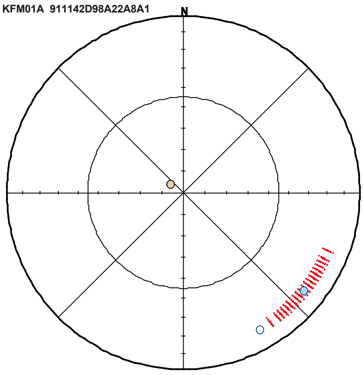
KFM01A 681142D98A22779E



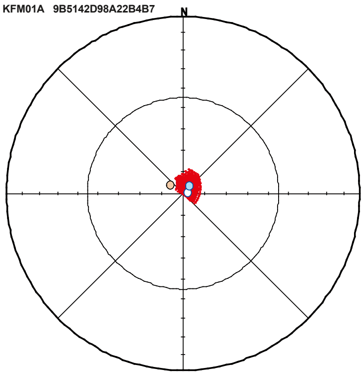
KFM01A 7E5142D98A227B60



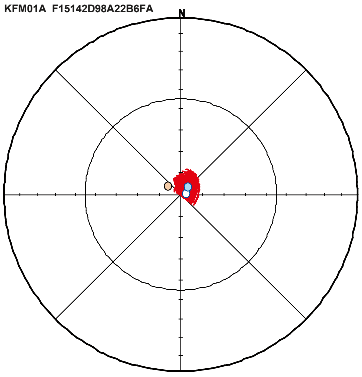
KFM01A 911142D98A22A8A1



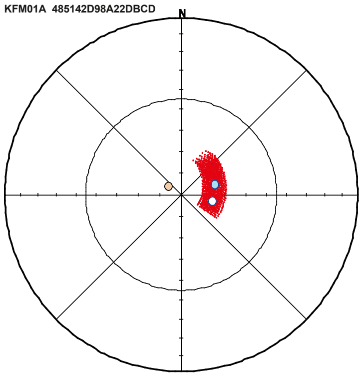
KFM01A 9B5142D98A22B4B7



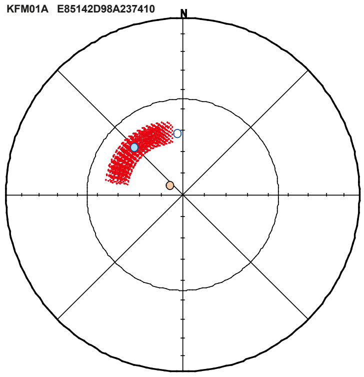
KFM01A F15142D98A22B6FA

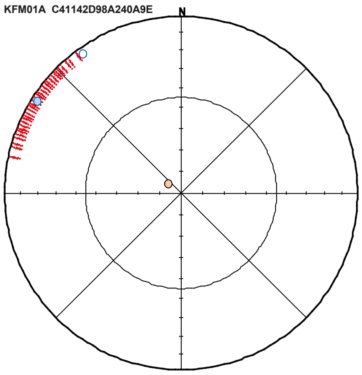


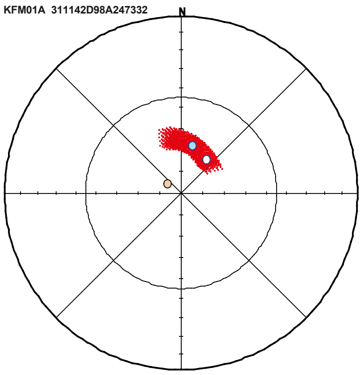
KFM01A 485142D98A22DBCD

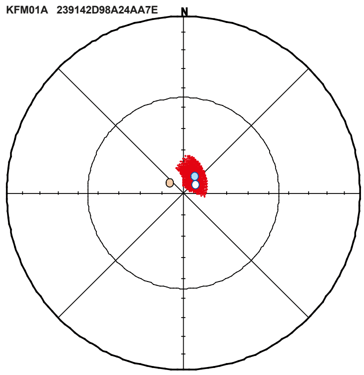


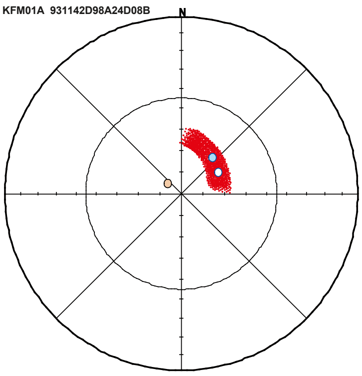
KFM01A E85142D98A237410

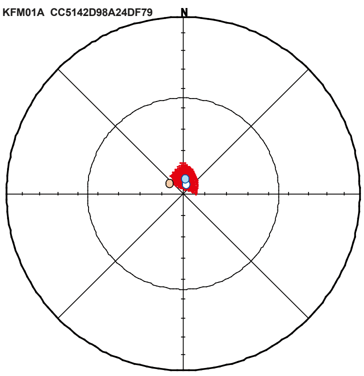


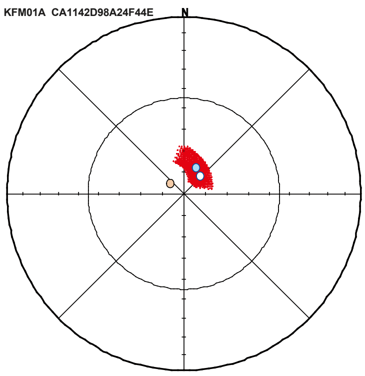


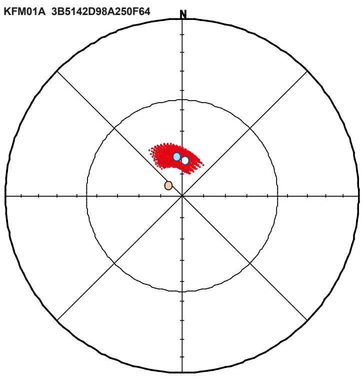


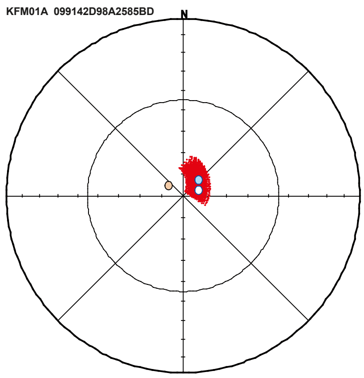












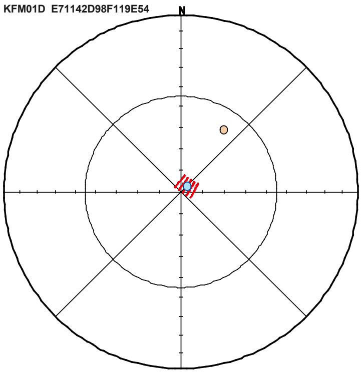
4.1.2 KFM01D

Below follow the sample space of uncertainty for the 34 PFL fractures in KFM01D. The seven fractures listed in Table 4-2 have a large uncertainty, i.e. $\Omega > 10°$ and consequently should be paid extra attention.

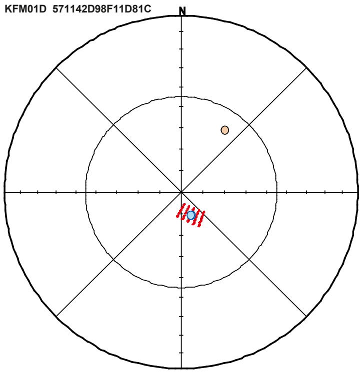
Table 4-2. Fractures in KFM01D needing extra attention.

Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
EC9142D98F11F9AE	X		14.7	0.2
609142D98F122D81	X		17.6	0.2
D0D142D98F122F1D	X		11.5	0.2
819142D98F123581	X		18.4	0.2
631142D98F140613	X		13.2	0.1
1D5142D98F14AE5F	X		11.8	0.3
7CD142D98F14D33F	X		14.2	0.2

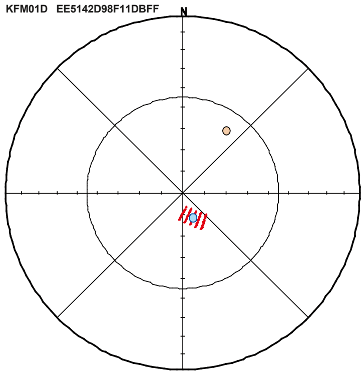
KFM01D E71142D98F119E54



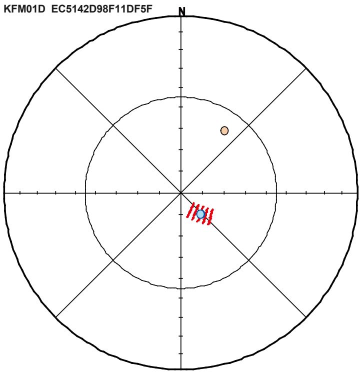
KFM01D 571142D98F11D81C



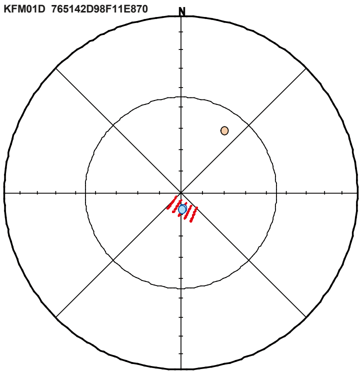
KFM01D EE5142D98F11DBFF



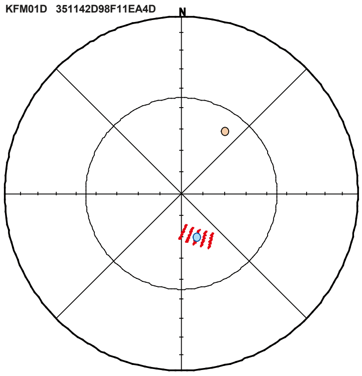
KFM01D EC5142D98F11DF5F



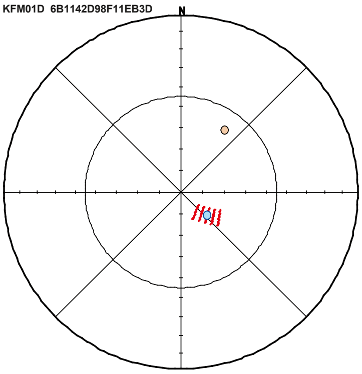
KFM01D 765142D98F11E870



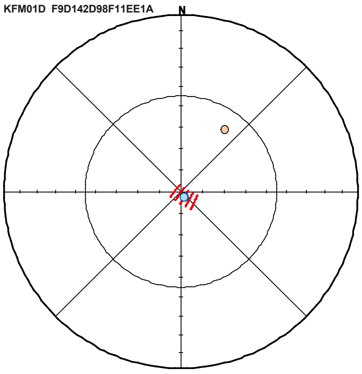
KFM01D 351142D98F11EA4D



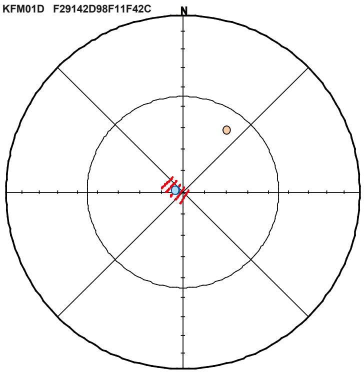
KFM01D 6B1142D98F11EB3D



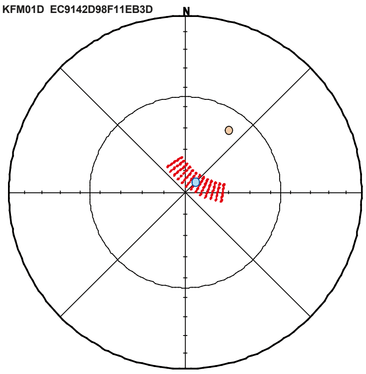
KFM01D F9D142D98F11EE1A



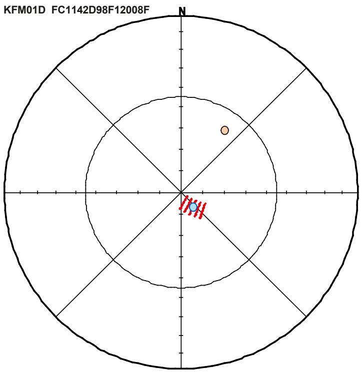
KFM01D F29142D98F11F42C



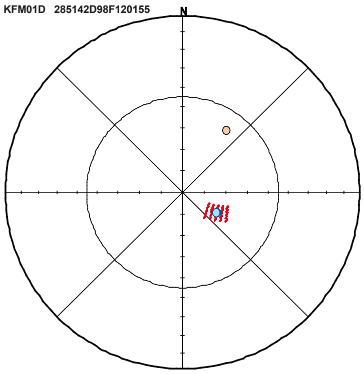
KFM01D EC9142D98F11EB3D



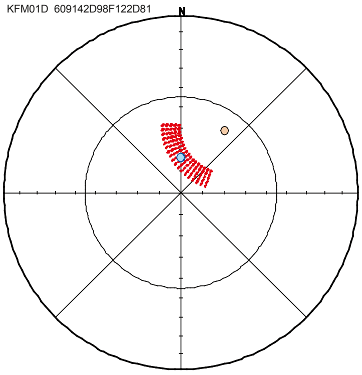
KFM01D FC1142D98F12008F



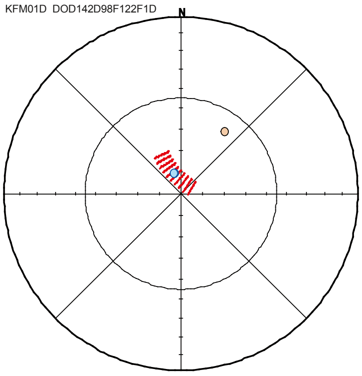
KFM01D 285142D98F120155



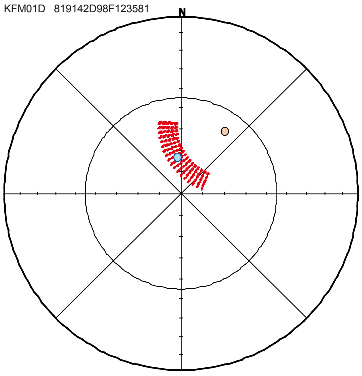
KFM01D 609142D98F122D81



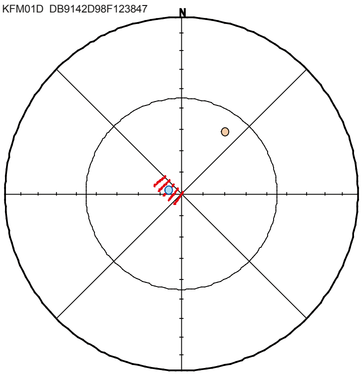
KFM01D DOD142D98F122F1D



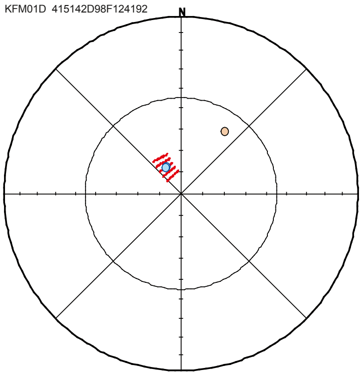
KFM01D 819142D98F123581



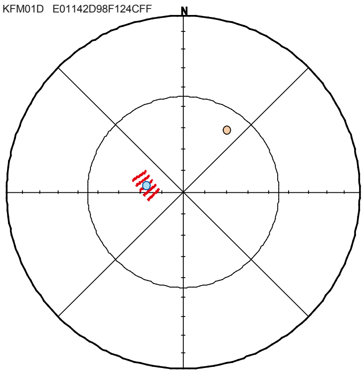
KFM01D DB9142D98F123847



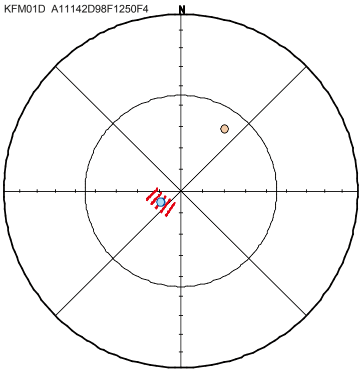
KFM01D 415142D98F124192



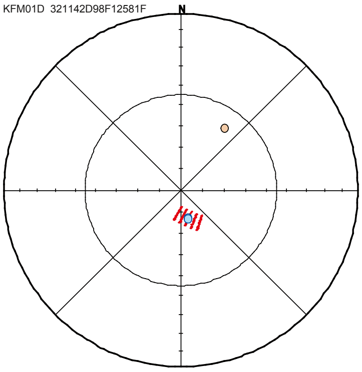
KFM01D E01142D98F124CFF



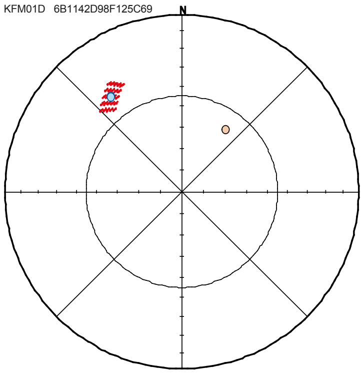
KFM01D A11142D98F1250F4



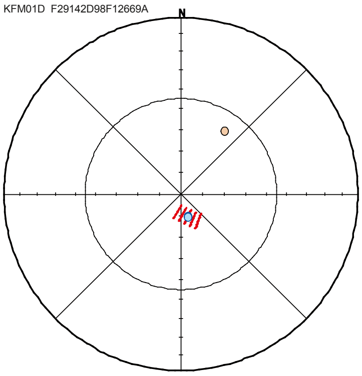
KFM01D 321142D98F12581F



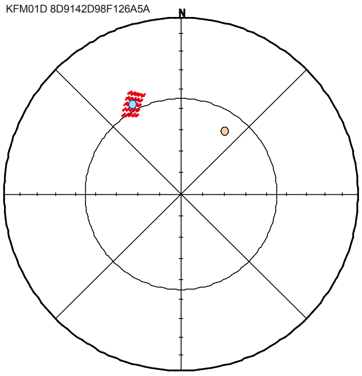
KFM01D 6B1142D98F125C69



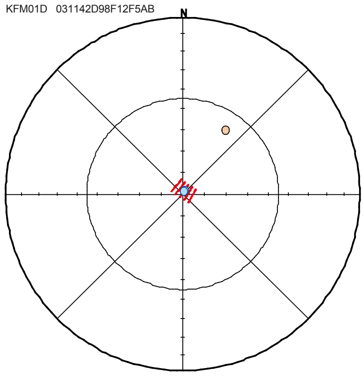
KFM01D F29142D98F12669A



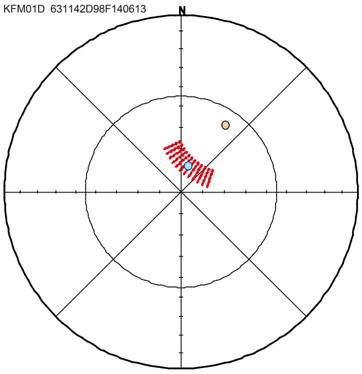
KFM01D 8D9142D98F126A5A



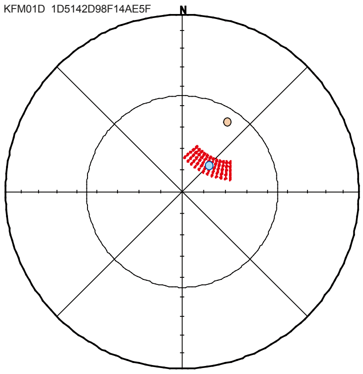
KFM01D 031142D98F12F5AB



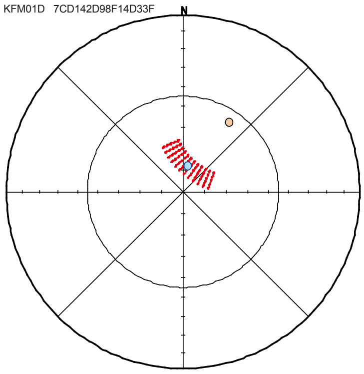
KFM01D 631142D98F140613



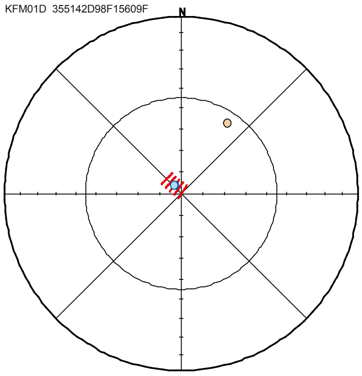
KFM01D 1D5142D98F14AE5F



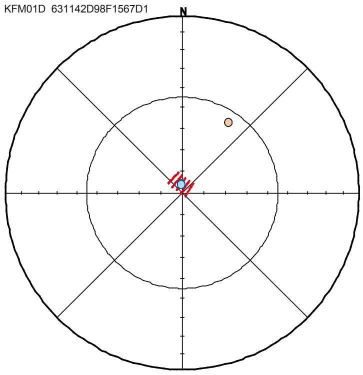
KFM01D 7CD142D98F14D33F



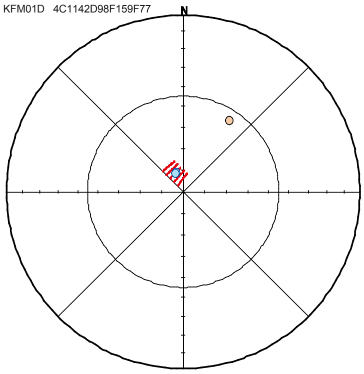
KFM01D 355142D98F15609F



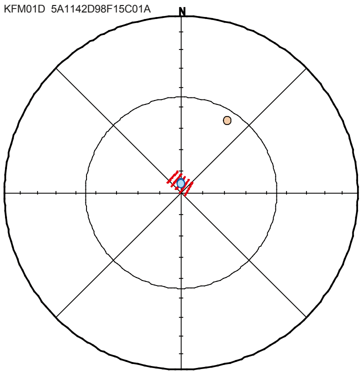
KFM01D 631142D98F1567D1



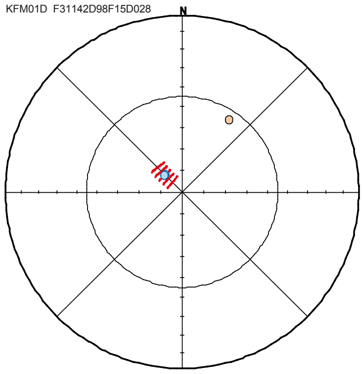
KFM01D 4C1142D98F159F77



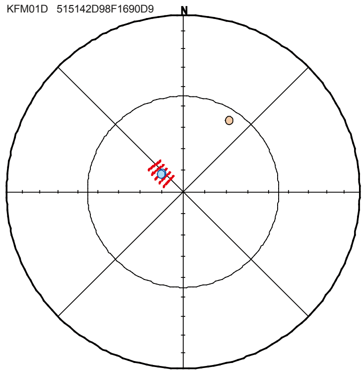
KFM01D 5A1142D98F15C01A



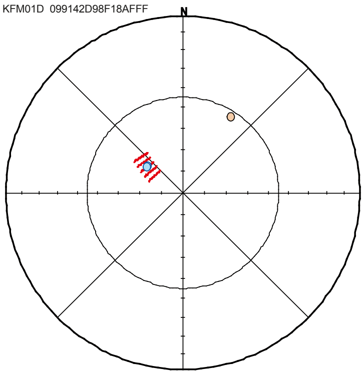
KFM01D F31142D98F15D028



KFM01D 515142D98F1690D9



KFM01D 099142D98F18AFFF

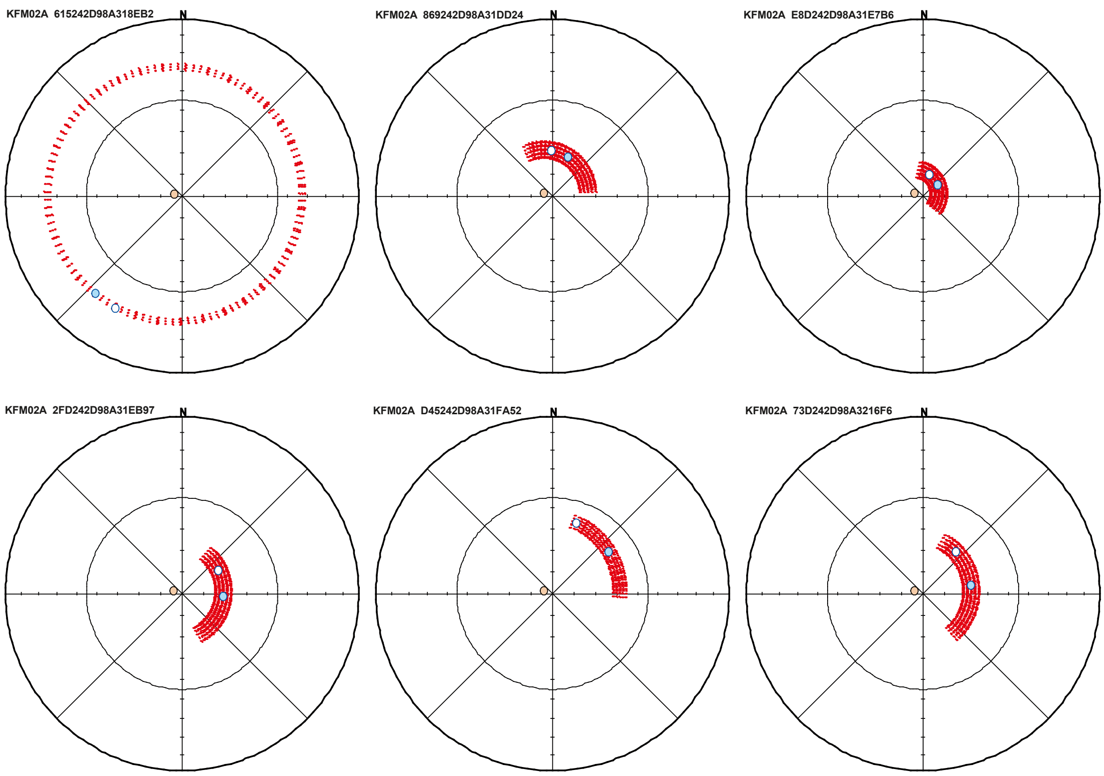


4.1.3 KFM02A

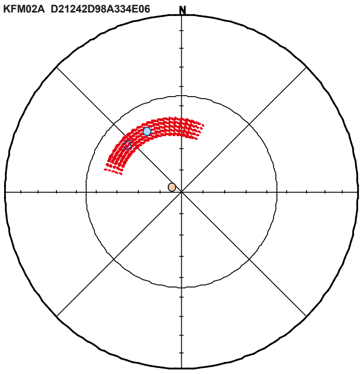
Below follow the sample space of uncertainty for the 22 PFL fractures in KFM02A. All the 22 fractures, listed in Table 4-3, should be paid extra attention since all of them have a large uncertainty, i.e. Ω > 10°. One of the 22 also have a change in orientation that is so large that the pre 2007 orientation is outside the sample space of the current uncertainty, i.e. the pre 2007 orientation is not valid on the 90th percentile. The fractures having large uncertainty can have an alternative interpretation of orientation compared to the best estimated orientation that is found in the table p_fract_core in /Sicada 2007/.

Table 4-3. Fractures in KFM02A needing extra attention.

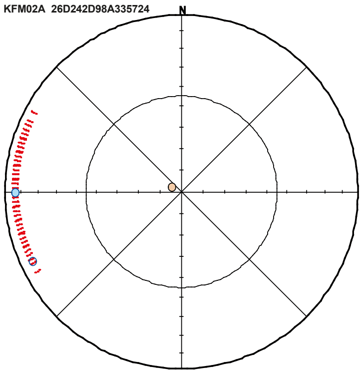
Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
615242D98A318EB2	X		90.0	9.8
869242D98A31DD24	X		20.9	8.0
E8D242D98A31E7B6	X		13.4	6.1
2FD242D98A31EB97	X		22.8	11.8
D45242D98A31FA52	X		21.9	19.2
73D242D98A3216F6	X		25.7	16.4
D21242D98A334E06	X		25.1	11.0
26D242D98A335724	X		28.5	24.6
A1D242D98A337817	X	X	18.6	19.5
D71242D98A3641AC	X		18.8	1.0
FB5242D98A364387	X		16.9	1.1
0FD242D98A3655CC	X		20.0	2.6
E7D242D98A36D0AE	X		13.8	4.8
5E5242D98A36D340	X		10.6	3.7
E65242D98A36E7CC	X		22.4	9.0
80D242D98A36E96A	X		15.4	6.2
935242D98A36EB4B	X		15.6	6.3
B45242D98A36FDB4	X		17.1	7.7
231242D98A3708CC	X		28.4	18.7
C49242D98A370B5C	X		26.0	15.7
B81242D98A371364	X		22.3	6.5
23D242D98A37202D	X		18.5	5.0



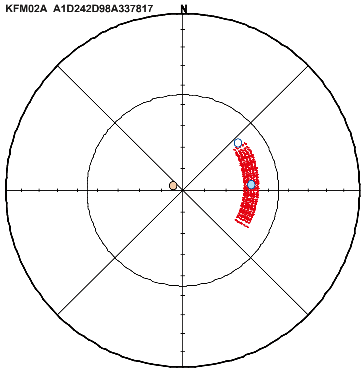
KFM02A D21242D98A334E06



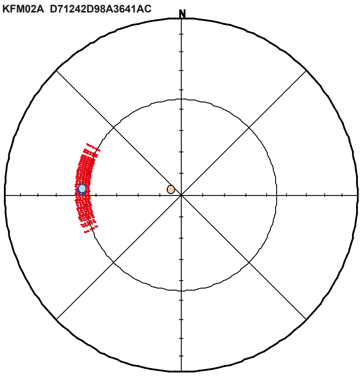
KFM02A 26D242D98A335724



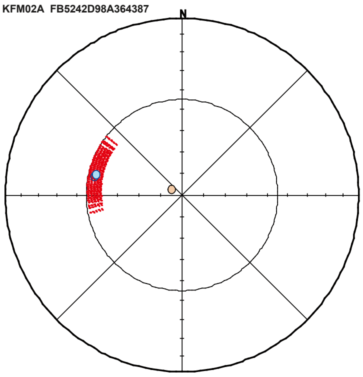
KFM02A A1D242D98A337817



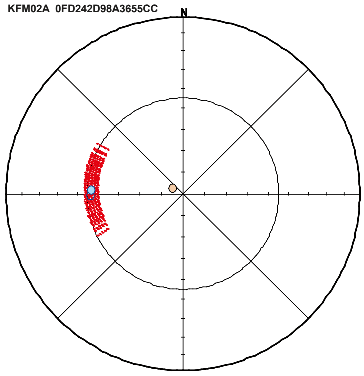
KFM02A D71242D98A3641AC



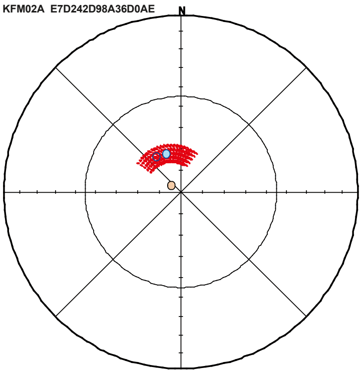
KFM02A FB5242D98A364387



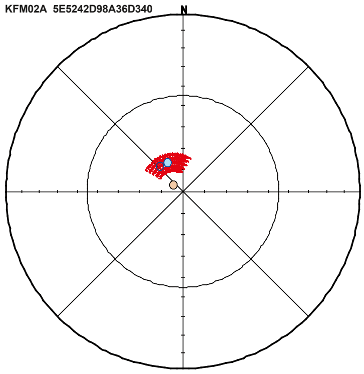
KFM02A 0FD242D98A3655CC



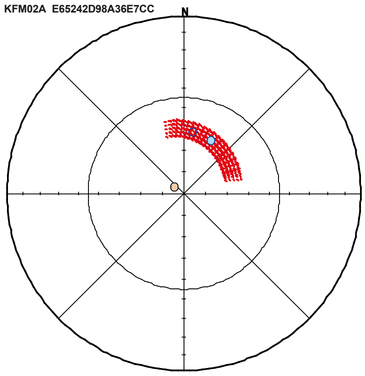
KFM02A E7D242D98A36D0AE



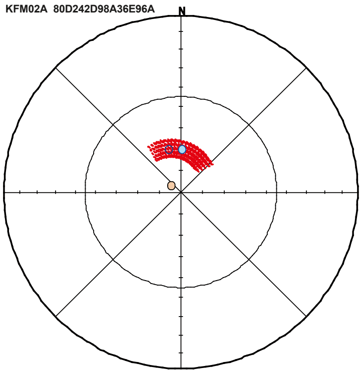
KFM02A 5E5242D98A36D340



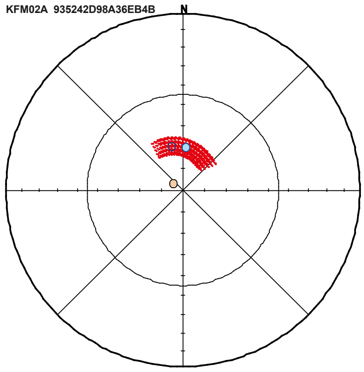
KFM02A E65242D98A36E7CC



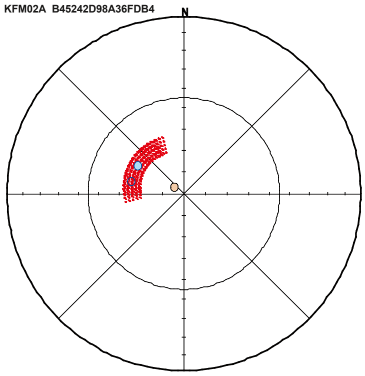
KFM02A 80D242D98A36E96A

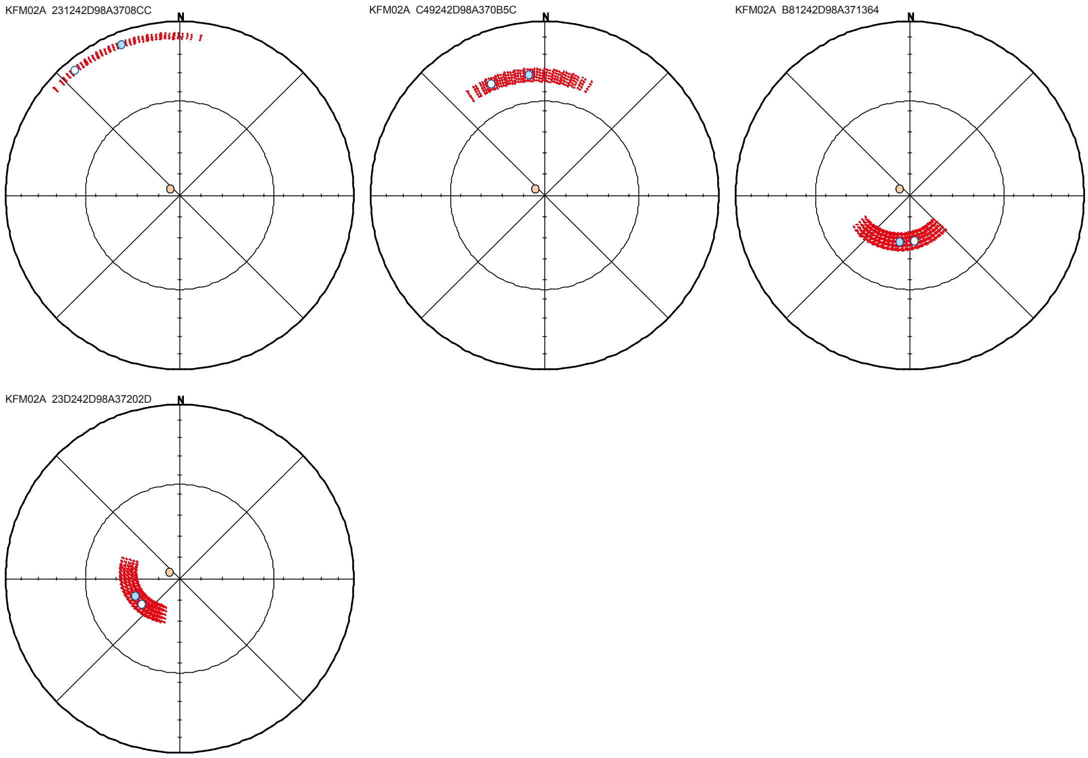


KFM02A 935242D98A36EB4B



KFM02A B45242D98A36FDB4





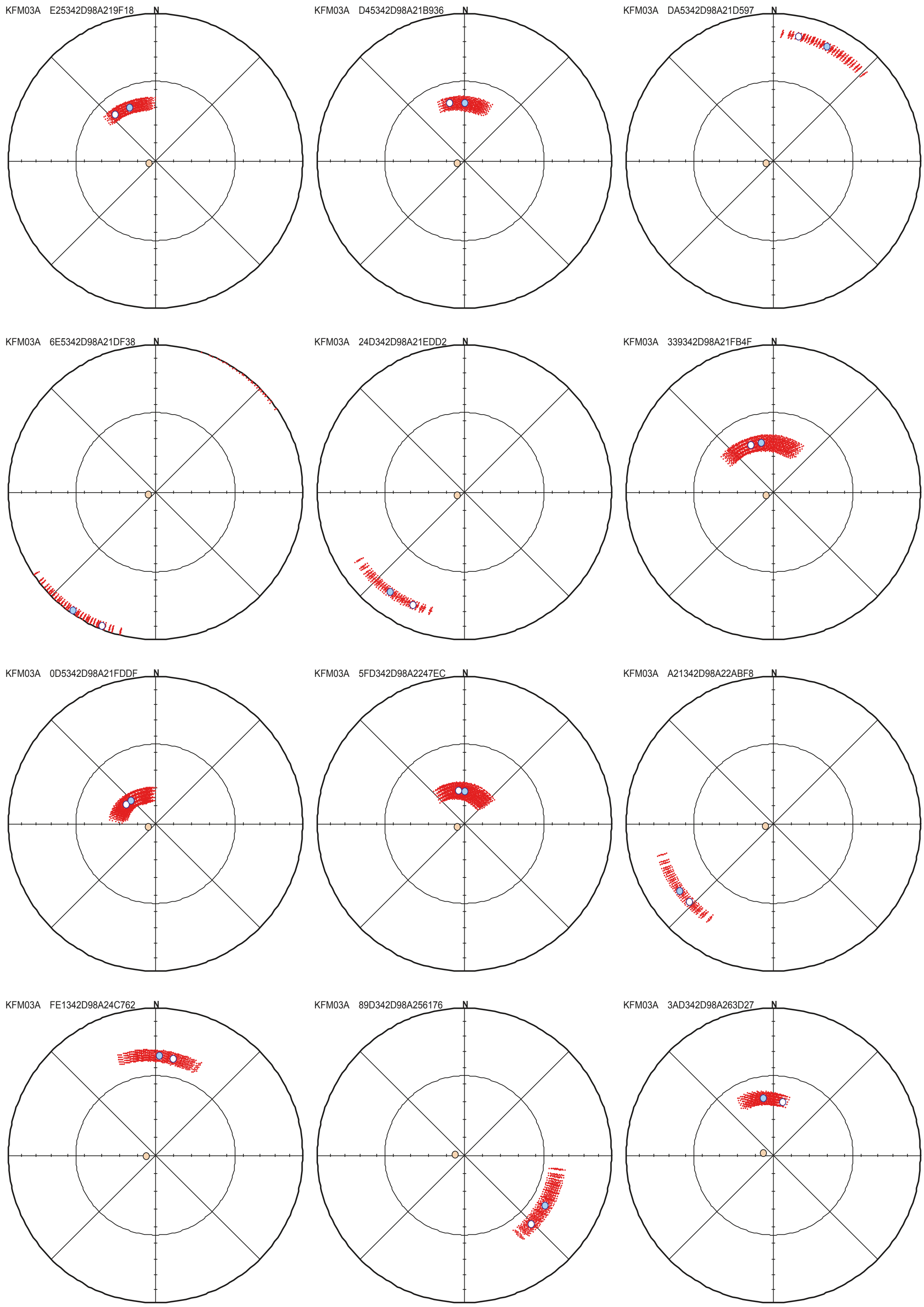
4.1.4 KFM03A

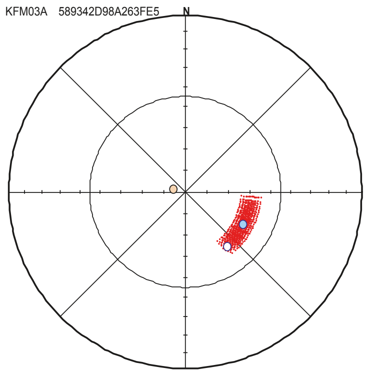
Below follow the sample space of uncertainty for the 23 PFL fractures in KFM03A. All fractures have an uncertainty such that Ω > 10°. In addition five of them also have a change in orientation so that the pre 2007 orientation is outside the 90th percentile sample space of the current uncertainty, i.e. the pre 2007 orientation is not valid, see Table 4-4. All the fractures can hence be interpreted having another orientation than the best estimated orientation that is found /Sicada 2007/.

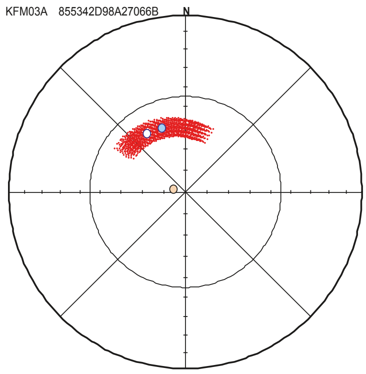
Table 4-4. Fractures in KFM03A needing extra attention.

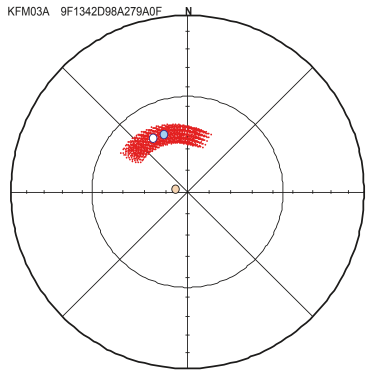
Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
E25342D98A219F18	X		14.5	8.6
D45342D98A21B936	X		14.6	7.9
DA5342D98A21D597	X		20.8	13.1
6E5342D98A21DF38	X		21.1	13.1
24D342D98A21EDD2	X		20.3	11.6
339342D98A21FB4F	X		22.9	5.6
0D5342D98A21FDDF	X		15.6	3.4
5FD342D98A2247EC	X		16.9	3.4
A21342D98A22ABF8	X		19.2	6.4
FE1342D98A24C762	X		20.5	6.6
89D342D98A256176	X		20.2	11.3
3AD342D98A263D27	X		13.9	10.5
589342D98A263FE5	X		14.4	11.9
855342D98A27066B	X		22.8	7.1
9F1342D98A279A0F	X		21.0	5.1
60D342D98A27D5E0	X		14.3	3.6
56D342D98A27DD10	X		21.0	5.8

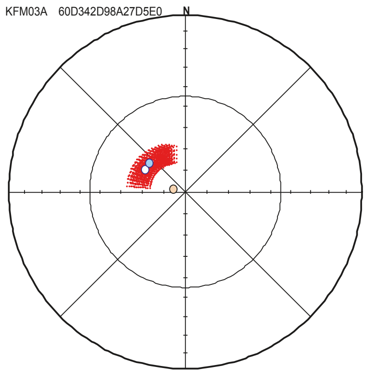
6F9342D98A281A35	X		21.1	6.5
AE5342D98A2EFA28	X	X	20.6	22.3
D19342D98A2EFA56	X	X	20.8	22.5
171342D98A2F1339	X	X	20.7	22.2
BA9342D98A2F175F	X	X	20.7	22.1
F29342D98A2F1783	X	X	20.9	22.4

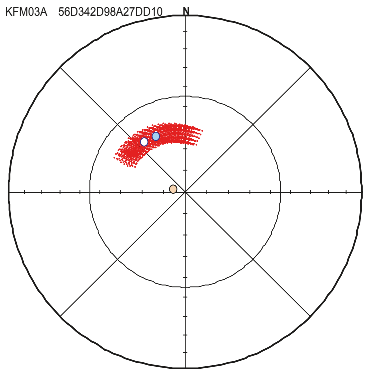


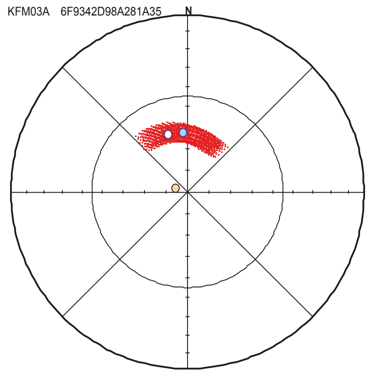


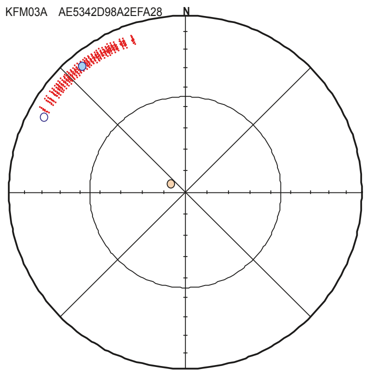


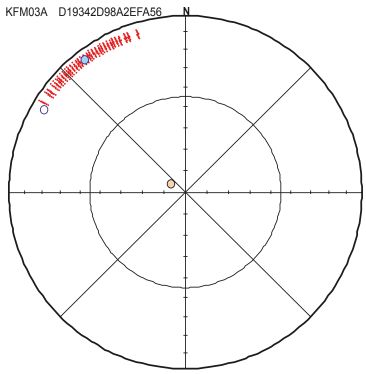


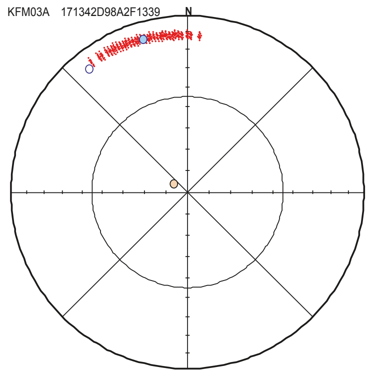


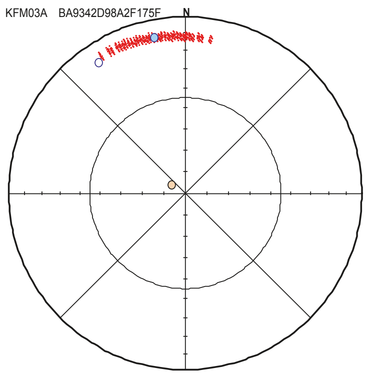


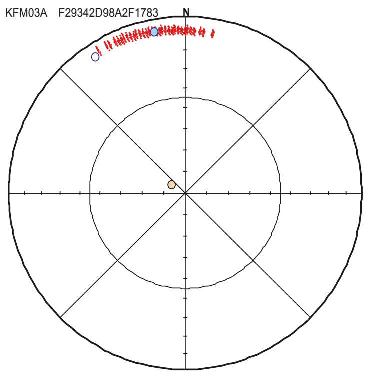










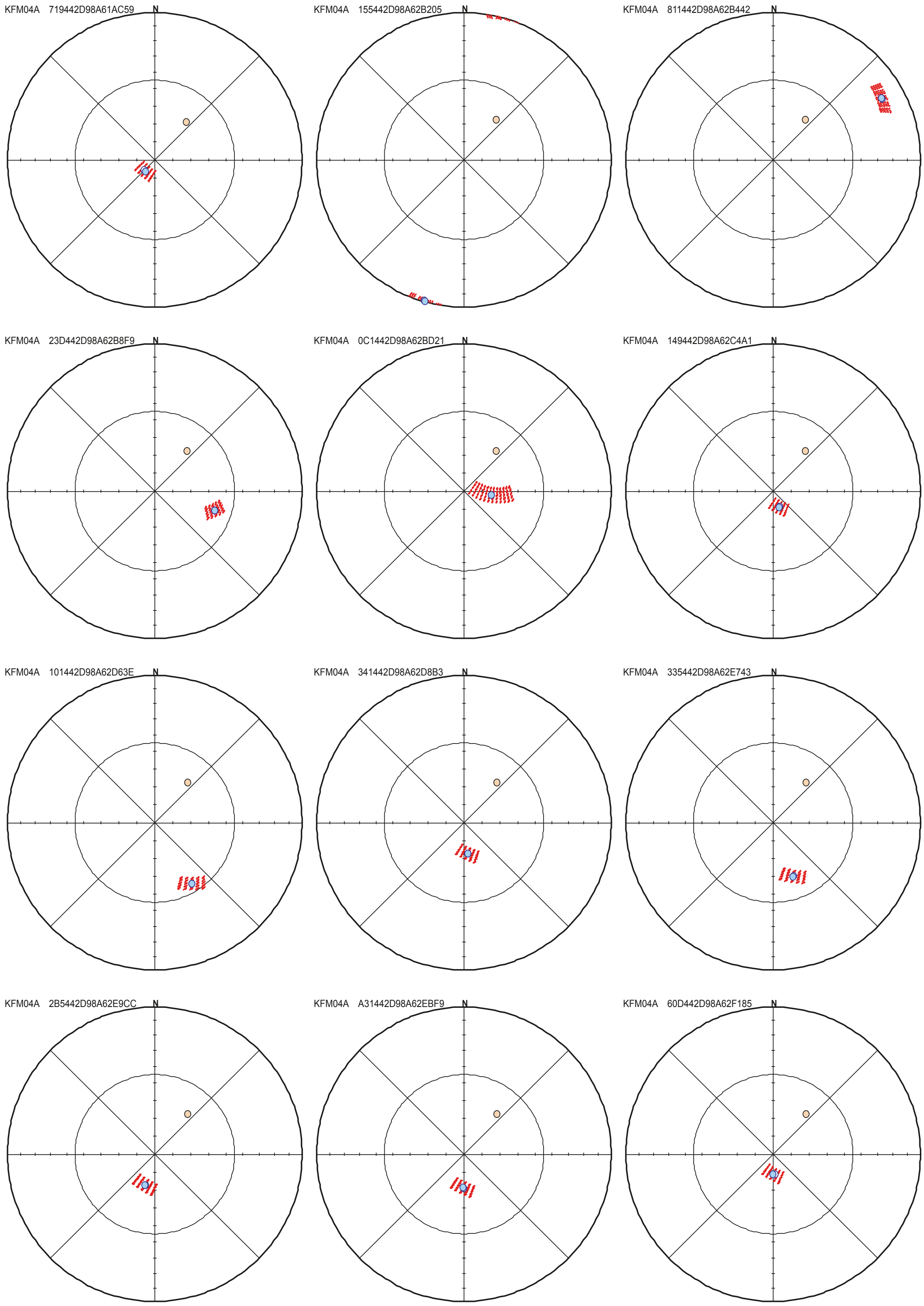


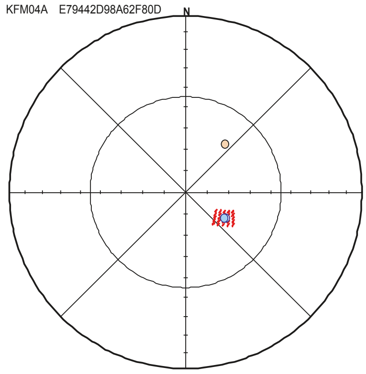
4.1.5 KFM04A

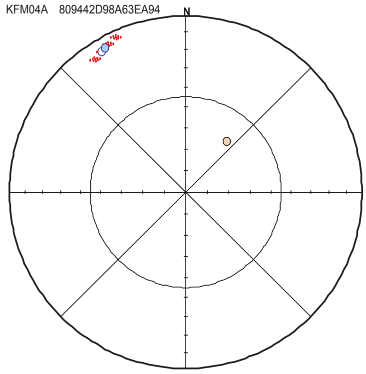
Below follow the sample space of uncertainty for the 16 PFL fractures in KFM04A. The two fractures listed in Table 4-5 need extra attention since they have an uncertainty, Ω, that is larger than 10°, implying that they can have a different orientation compared to the best estimate orientation that is found in the table p_fract_core in /Sicada 2007/.

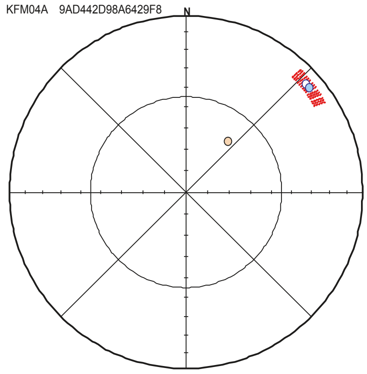
Table 4-5. Fractures in KFM04A needing extra attention.

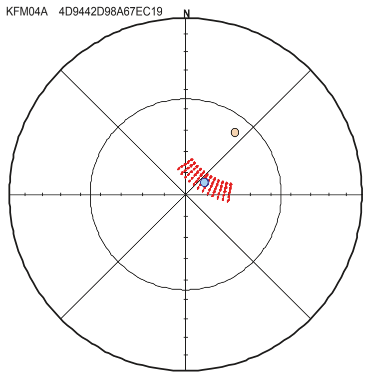
Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
0C1442D98A62BD21	×		12.5	0.1
4D9442D98A67EC19	×		13.7	0.3











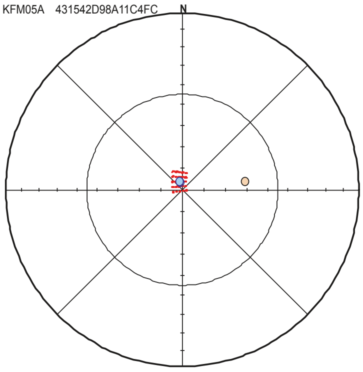
4.1.6 KFM05A

Below follow the sample space of uncertainty for the 19 PFL fractures in KFM05A. Extra attention should be paid to the eleven fractures listed in Table 4-6. These fractures have a large uncertainty, i.e. $\Omega > 10°$ and can have an alternative interpretation of orientation compared to the best estimate orientation that is found in the table p_fract_core in /Sicada 2007/.

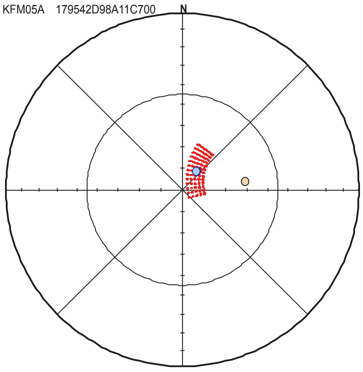
Table 4-6. Fractures in KFM05A needing extra attention.

Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
179542D98A11C700	X		12.6	0.6
B4D542D98A11D35E	X		11.8	0.6
07D542D98A11D58F	X		12.7	0.5
735542D98A11DBE3	X		13.4	0.5
875542D98A11E4D3	X		13.3	0.7
DB1542D98A11E5C6	X		12.9	0.6
1ED542D98A11EBD2	X		13.5	0.6
6BD542D98A11FEE1	X		14.0	0.6
735542D98A12893B	X		11.9	0.6
6B9542D98A128C3A	X		14.0	1.1
D21542D98A129225	X		10.9	1.0

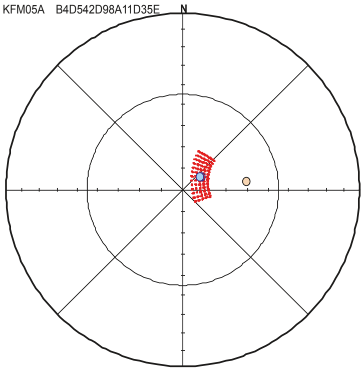
KFM05A 431542D98A11C4FC



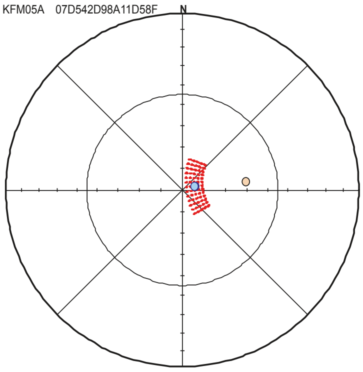
KFM05A 179542D98A11C700



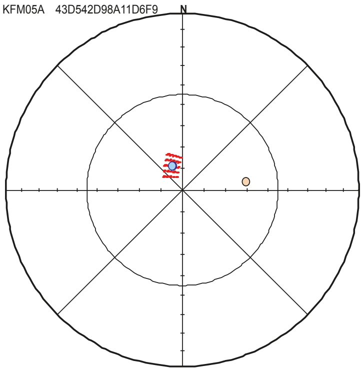
KFM05A B4D542D98A11D35E



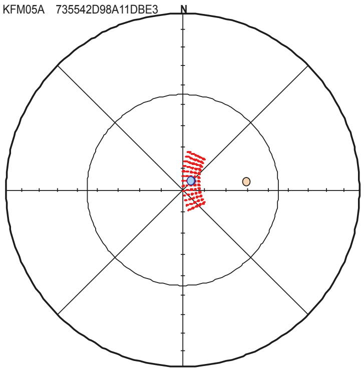
KFM05A 07D542D98A11D58F



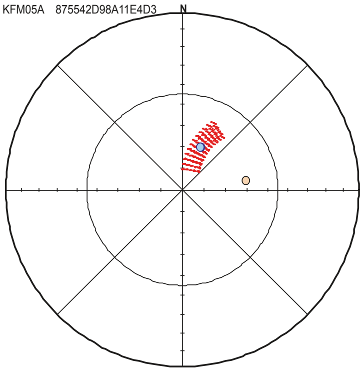
KFM05A 43D542D98A11D6F9



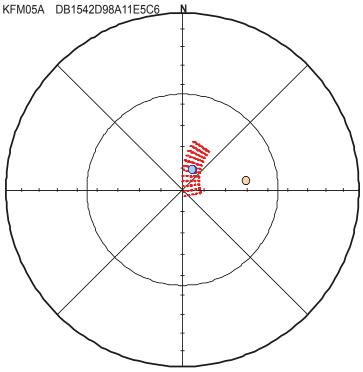
KFM05A 735542D98A11DBE3



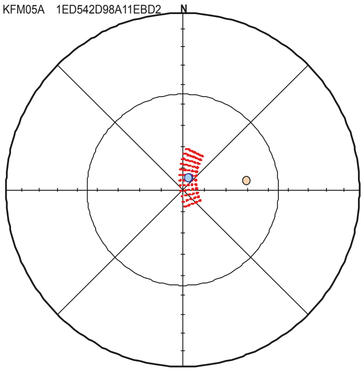
KFM05A 875542D98A11E4D3



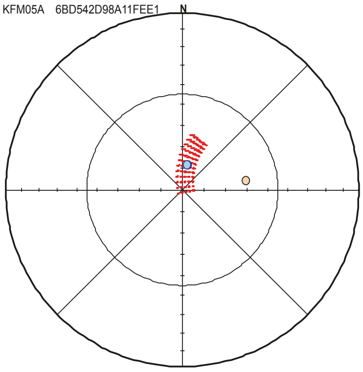
KFM05A DB1542D98A11E5C6



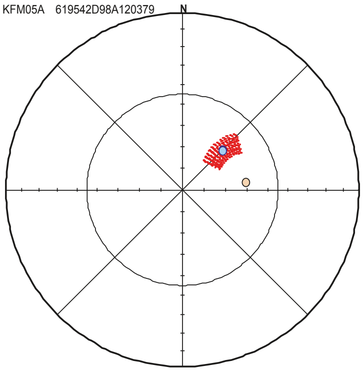
KFM05A 1ED542D98A11EBD2



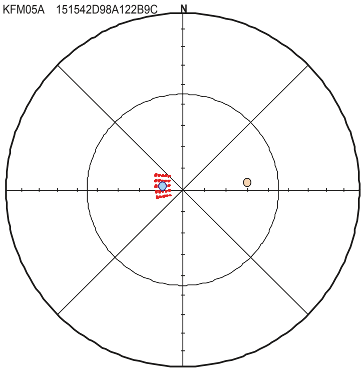
KFM05A 6BD542D98A11FEE1

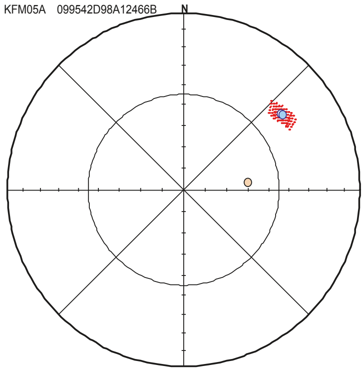


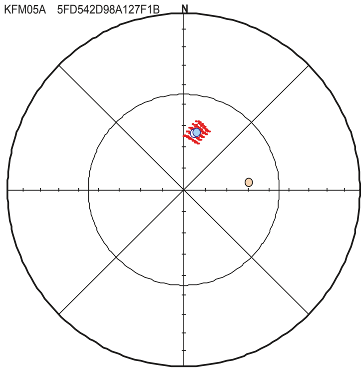
KFM05A 619542D98A120379

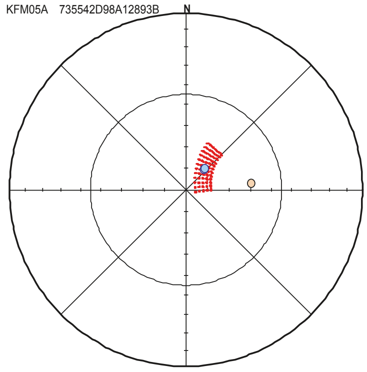


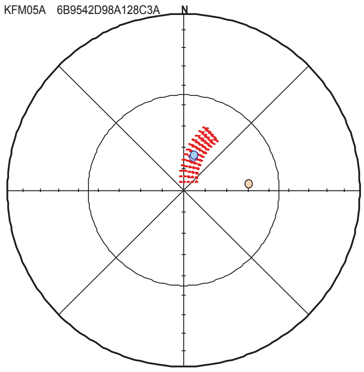
KFM05A 151542D98A122B9C

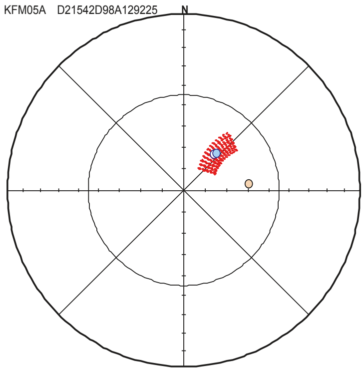


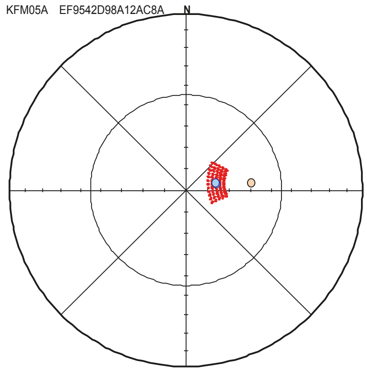










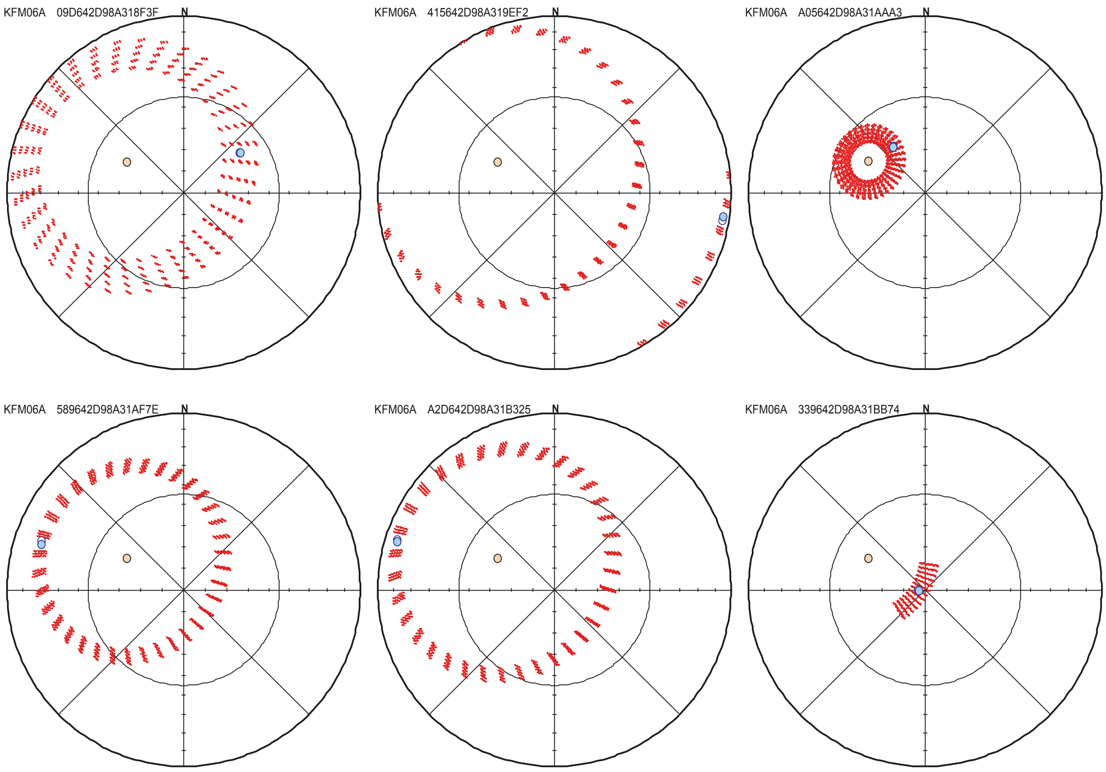


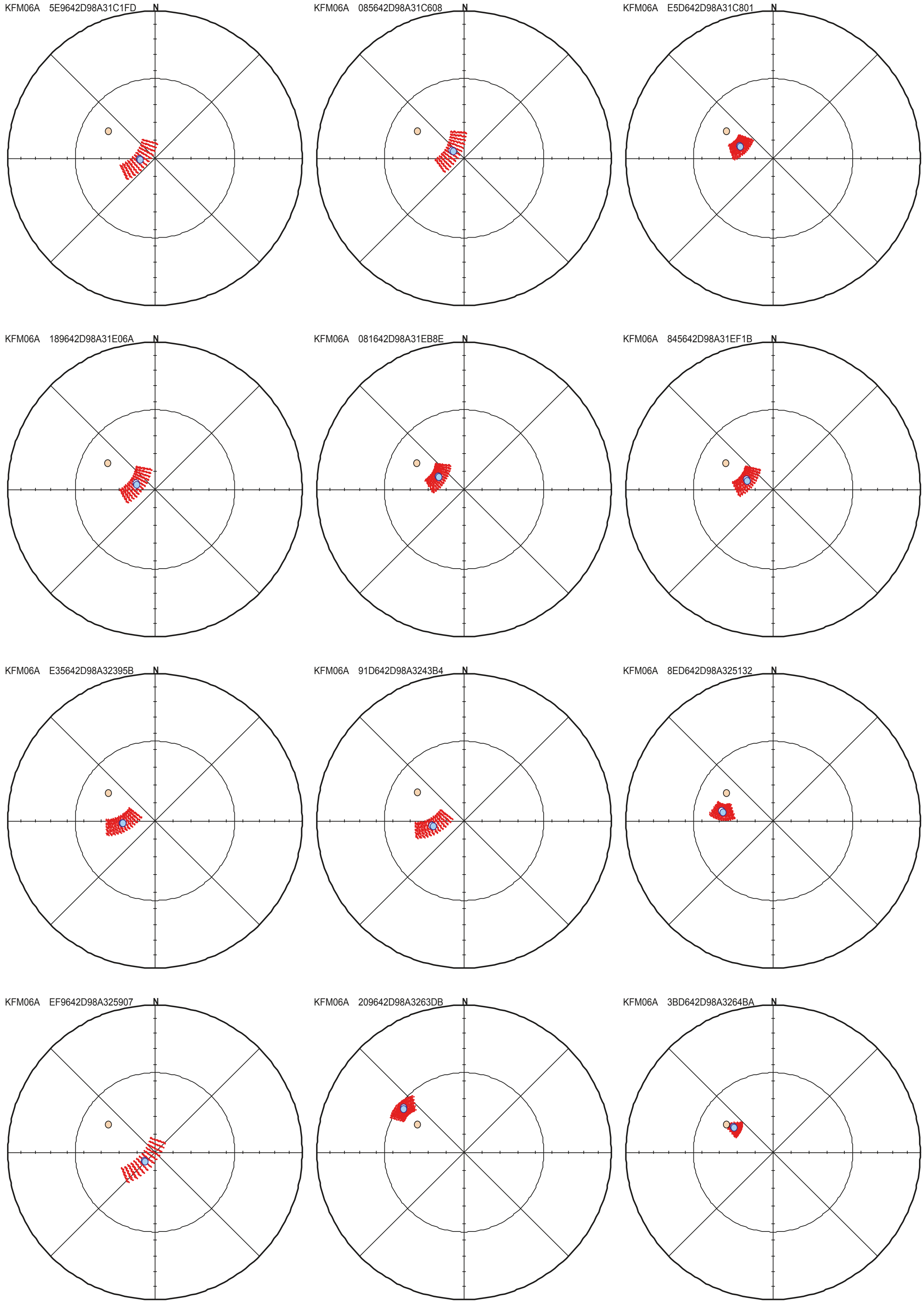
4.1.7 KFM06A

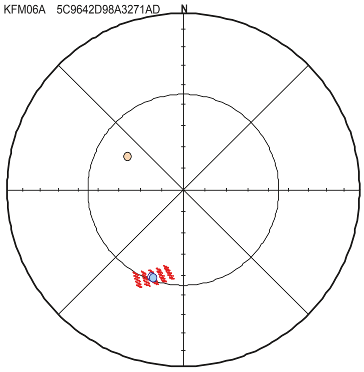
Below follow the sample space of uncertainty for the 38 PFL fractures in KFM06A. Extra attention should be paid to the 17 fractures listed in Table 4-7 since they have an uncertainty, Ω, that is larger than 10°. The first five PFL fractures are mapped in a piece of core where there is no orientation of the Bips image implaying that the uncertainty in beta angle is 180°. Fractures having large uncertainty can thus have an alternative interpretation of orientation compared to the best estimate orientation that is found in the table p_fract_core in /Sicada 2007/.

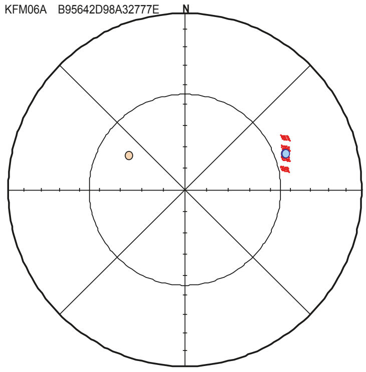
Table 4-7. Fractures in KFM06A needing extra attention.

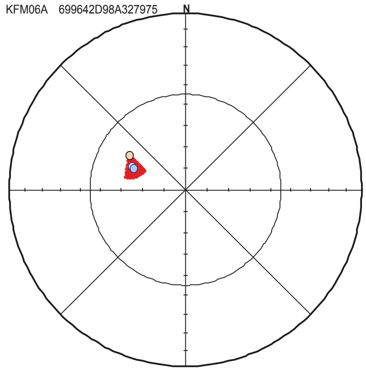
Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
09D642D98A318F3F	X		89.9	0.3
415642D98A319EF2	X		88.2	1.3
A05642D98A31AAA3	X		29.9	0.6
589642D98A31AF7E	X		90.0	1.1
A2D642D98A31B325	X		90.0	0.8
339642D98A31BB74	X		14.3	0.6
5E9642D98A31C1FD	X		12.8	0.6
085642D98A31C608	X		12.3	0.6
189642D98A31E06A	X		11.3	0.6
E35642D98A32395B	X		10.8	0.6
91D642D98A3243B4	X		11.4	0.8
EF9642D98A325907	X		14.9	0.6
60D642D98A327BFD	X		11.0	0.6
971642D98A328C94	X		14.4	0.5
F89642D98A3291A8	X		11.1	0.5
D95642D98A32C0DB	X		14.4	0.8
C89642D98A32C20A	X		15.2	0.8

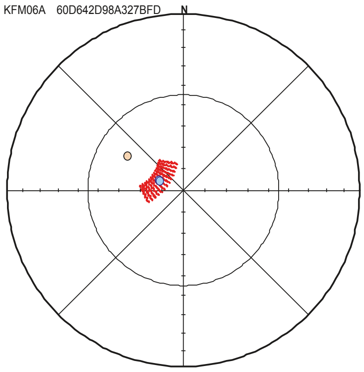


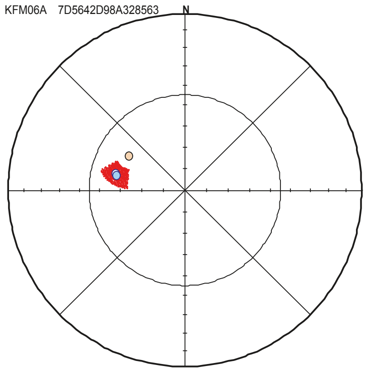

KFM06A 5E9642D98A31C1FD N
KFM06A 085642D98A31C608 N
KFM06A E5D642D98A31C801 N
KFM06A 189642D98A31E06A N
KFM06A 081642D98A31EB8E N
KFM06A 845642D98A31EF1B N
KFM06A E35642D98A32395B N
KFM06A 91D642D98A3243B4 N
KFM06A 8ED642D98A325132 N
KFM06A EF9642D98A325907 N
KFM06A 209642D98A3263DB N
KFM06A 3BD642D98A3264BA N

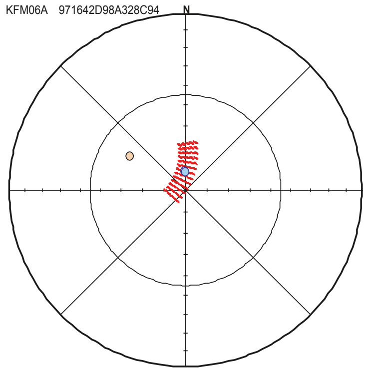

KFM06A 5C9642D98A3271AD
N

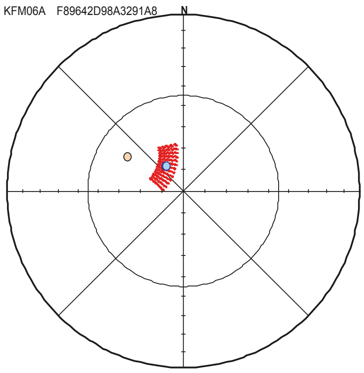

KFM06A B95642D98A32777E
N

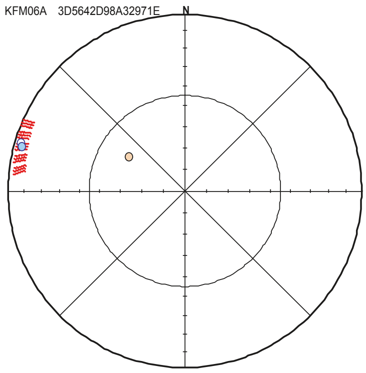

KFM06A 699642D98A327975
N

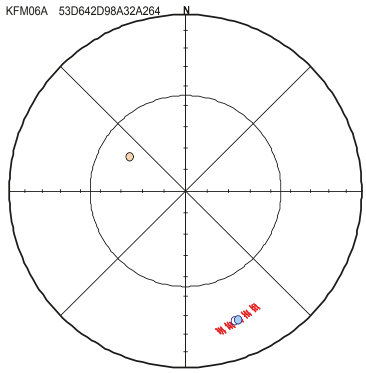

KFM06A 60D642D98A327BFD
N

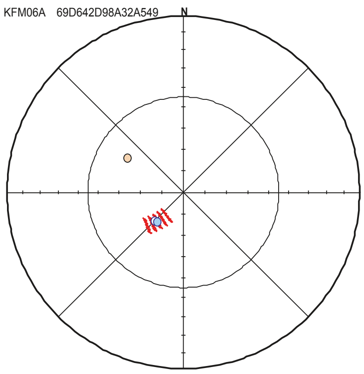

KFM06A 7D5642D98A328563
N

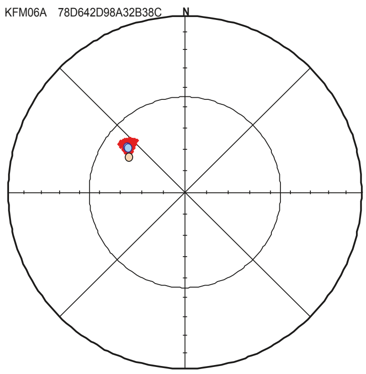

KFM06A 971642D98A328C94
N

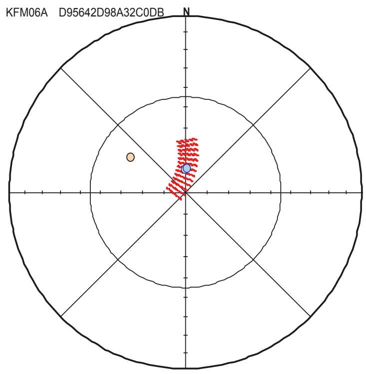

KFM06A F89642D98A3291A8
N

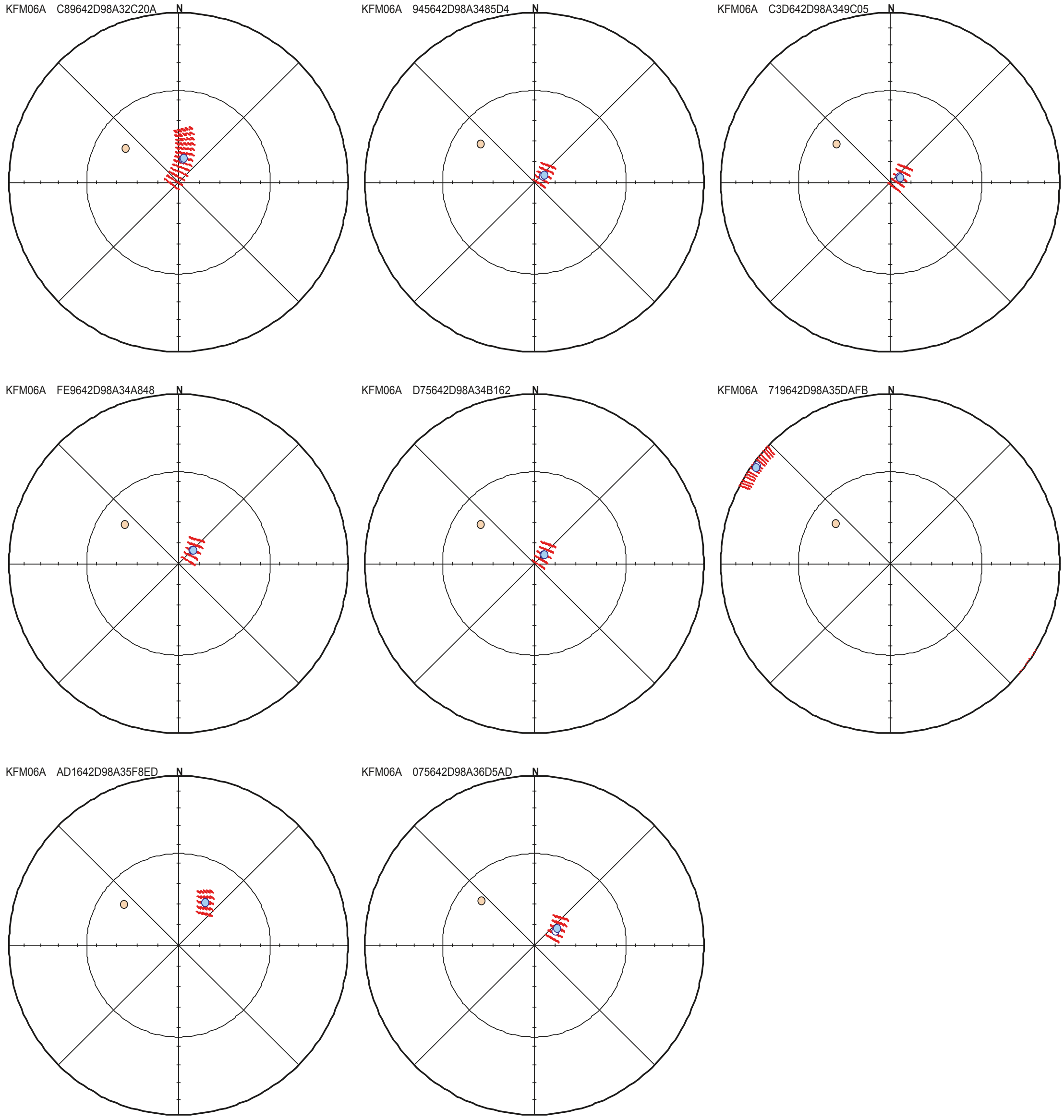

KFM06A 3D5642D98A32971E
N


KFM06A 53D642D98A32A264
N


KFM06A 69D642D98A32A549
N


KFM06A 78D642D98A32B38C
N


KFM06A D95642D98A32C0DB
N

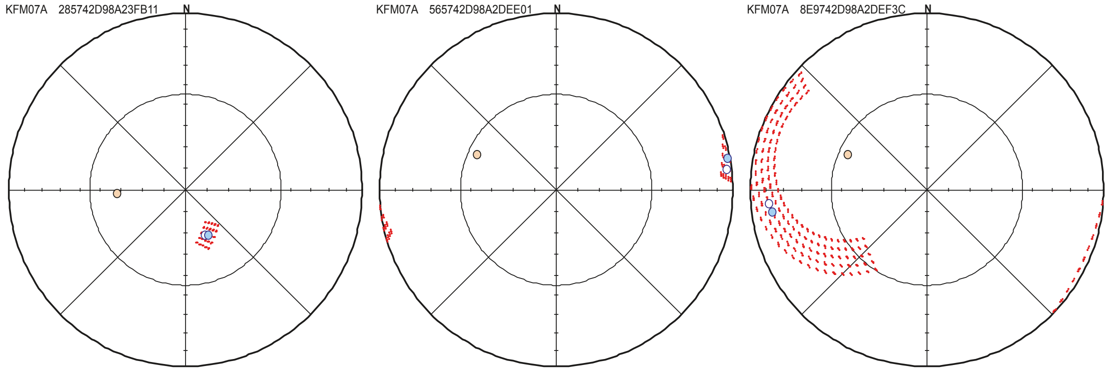


4.1.8 KFM07A

Below follow the sample space of uncertainty for the 3 PFL fractures in KFM07A. One of these fractures have large maximum uncertainty, 53.5°, see Table 4-8, and need to be paid extra attention. The fracture can have an alternative interpretation of orientation compared to the best estimate orientation that is found in the table p_fract_core in /Sicada 2007/.

Table 4-8. Fracture in KFM07A needing extra attention.

Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
8E9742D98A2DEF3C	X		53.5	3.5

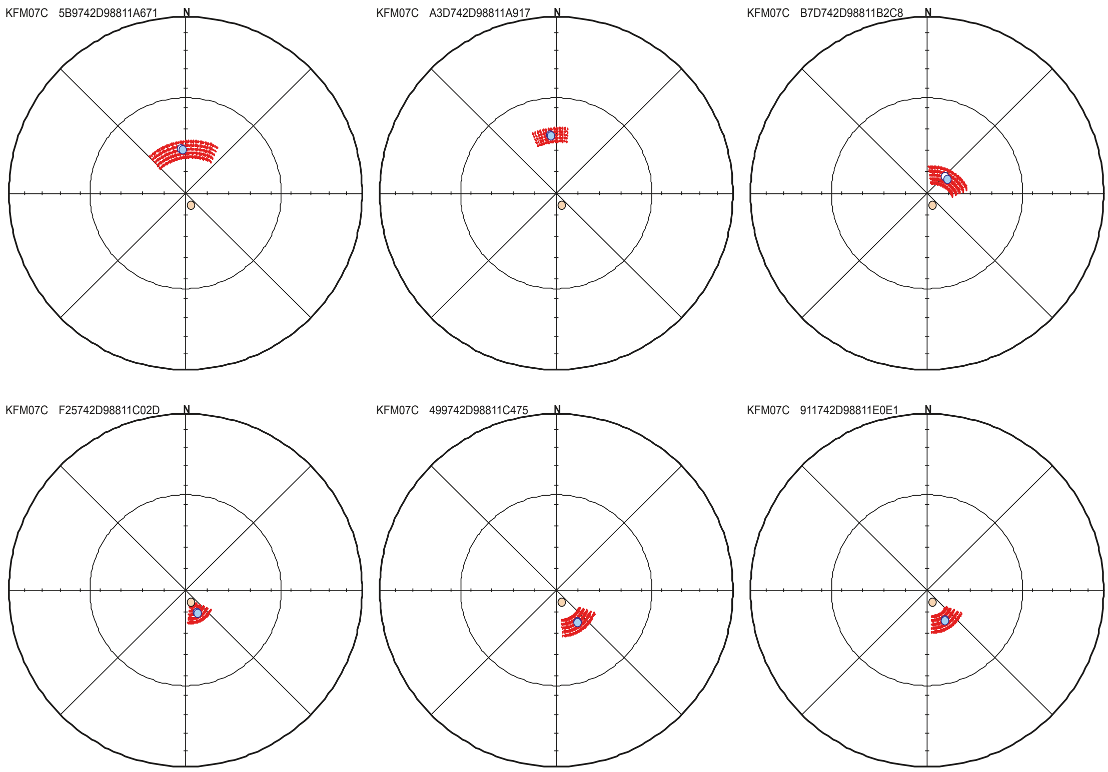


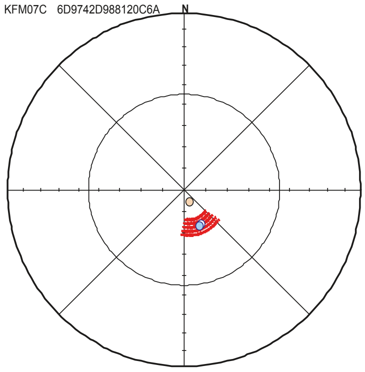
4.1.9 KFM07C

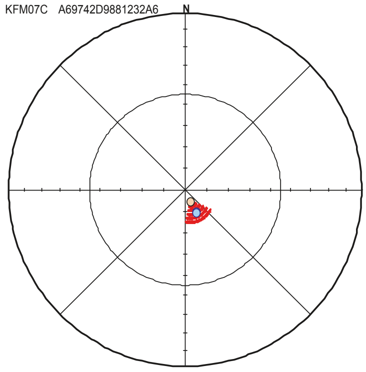
Below follow the sample space of uncertainty for the 13 PFL fractures in KFM07C. Extra attention should be paid to the three fractures listed in Table 4-9. These fractures have an uncertainty, Ω, larger than 10°, implying they can have an alternative interpretation of orientation compared to the best estimate orientation that is found in the table p_fract_core in /Sicada 2007/.

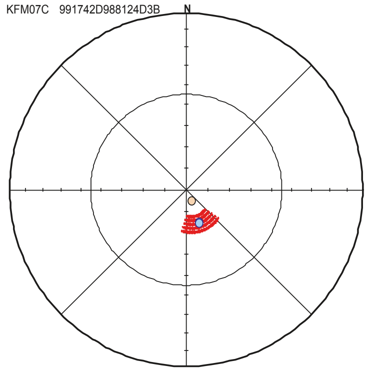
Table 4-9. Fractures in KFM07C needing extra attention.

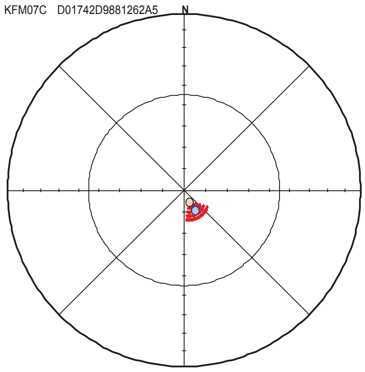
Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
5B9742D98811A671	X		15.4	1.1
B7D742D98811B2C8	X		10.3	1.7
0C9742D9881440E7	X		12.5	2.6

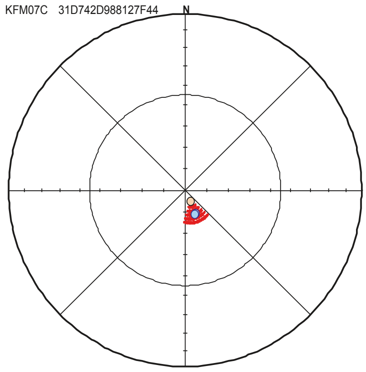


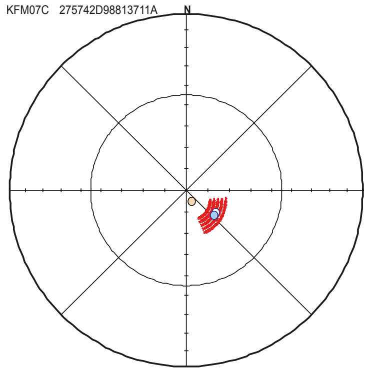


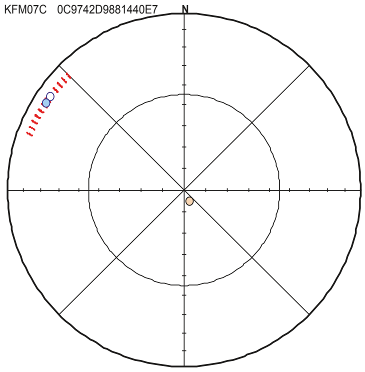












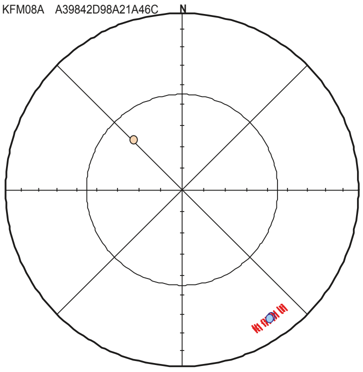
4.1.10 KFM08A

Below follow the sample space of uncertainty for the 32 PFL fractures in KFM08A. The five fractures listed in Table 4-10 need to be paid extra attention since these fractures have an uncertainty, Ω, larger than 10°, and thus can have an alternative interpretation of orientation compared to the best estimate orientation that is found in the table p_fract_core in /Sicada 2007/.

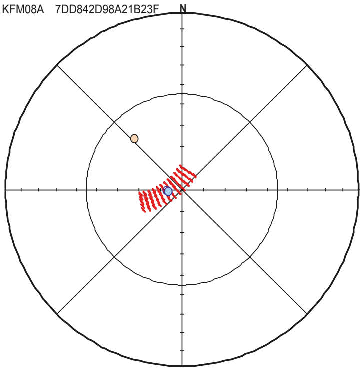
Table 4-10. Fractures in KFM08A needing extra attention.

Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
7DD842D98A21B23F	X		14.4	0.8
DE9842D98A21C839	X		13.8	0.5
2AD842D98A2201E2	X		14.2	0.8
005842D98A2691DA	X		14.2	1.4
D19842D98A26FF6A	X		13.2	1.9

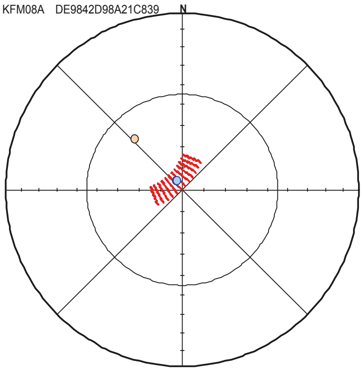
KFM08A A39842D98A21A46C



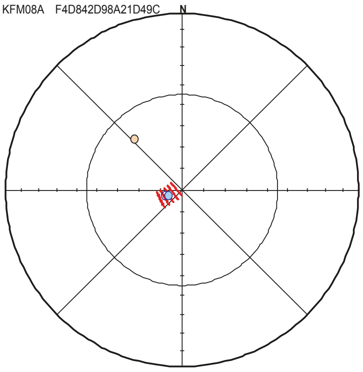
KFM08A 7DD842D98A21B23F



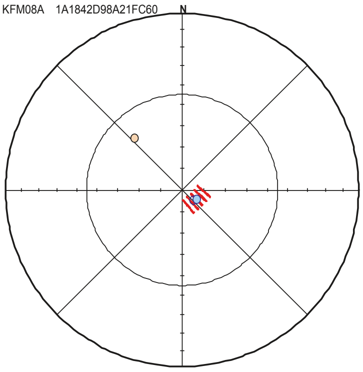
KFM08A DE9842D98A21C839



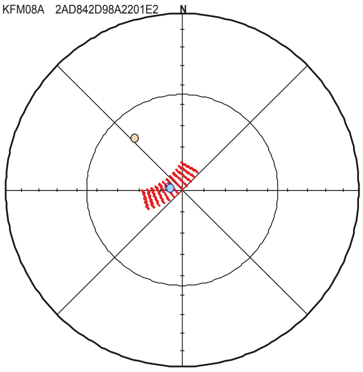
KFM08A F4D842D98A21D49C



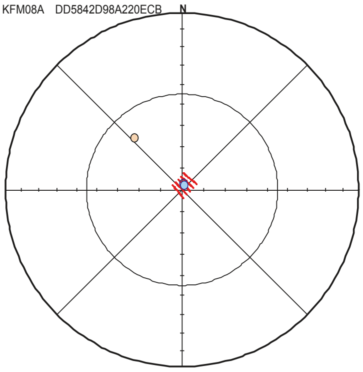
KFM08A 1A1842D98A21FC60



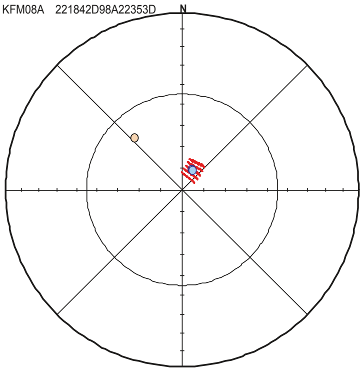
KFM08A 2AD842D98A2201E2



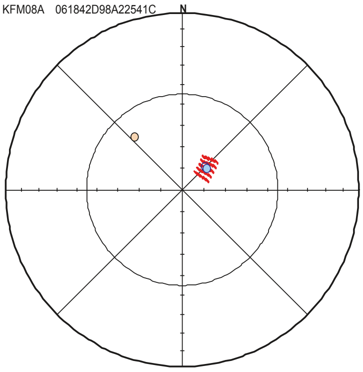
KFM08A DD5842D98A220ECB



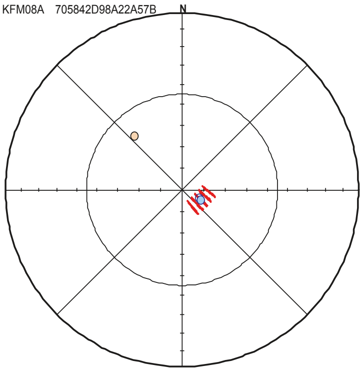
KFM08A 221842D98A22353D



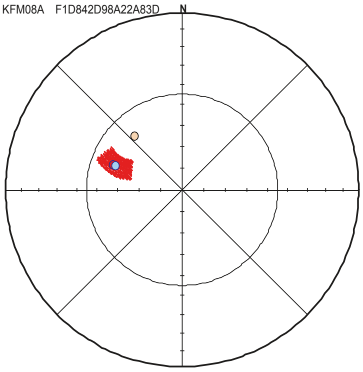
KFM08A 061842D98A22541C



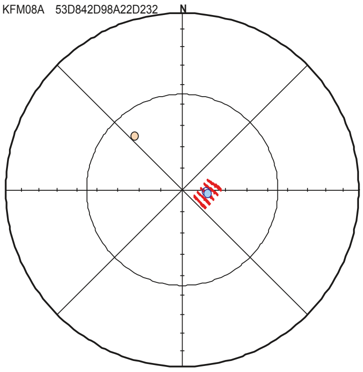
KFM08A 705842D98A22A57B



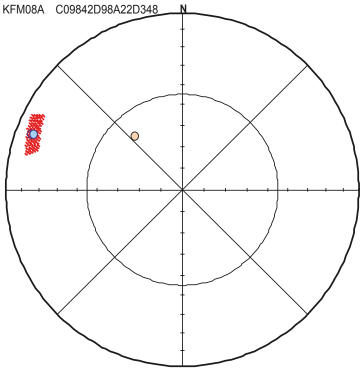
KFM08A F1D842D98A22A83D



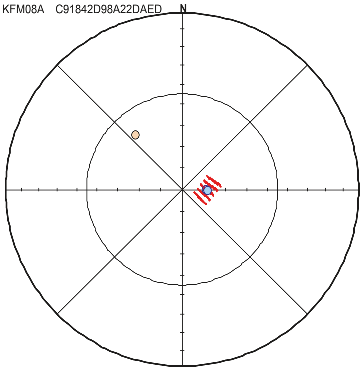
KFM08A 53D842D98A22D232



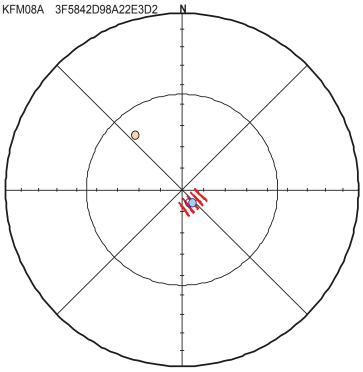
KFM08A C09842D98A22D348



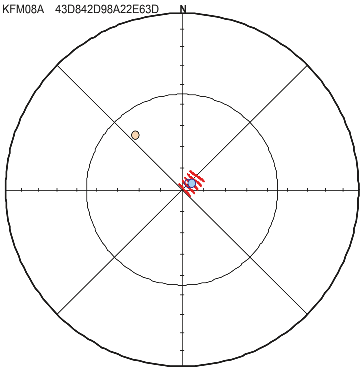
KFM08A C91842D98A22DAED



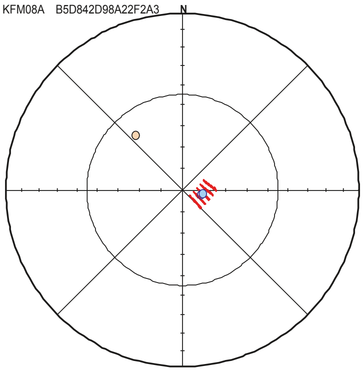
KFM08A 3F5842D98A22E3D2



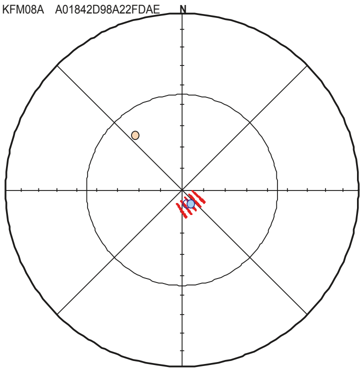
KFM08A 43D842D98A22E63D



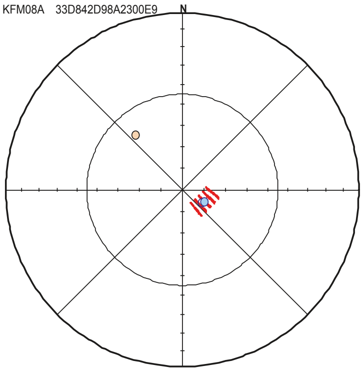
KFM08A B5D842D98A22F2A3



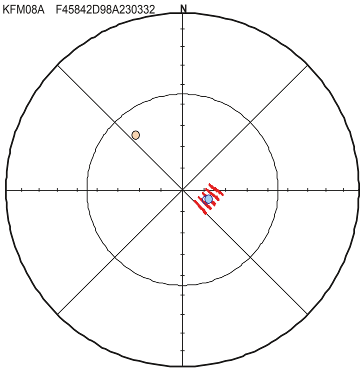
KFM08A A01842D98A22FDAE



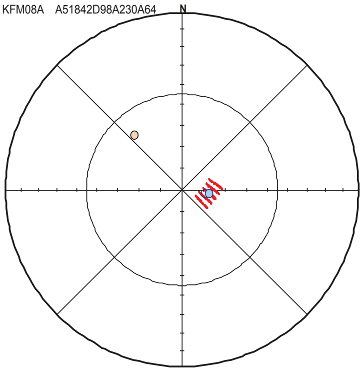
KFM08A 33D842D98A2300E9



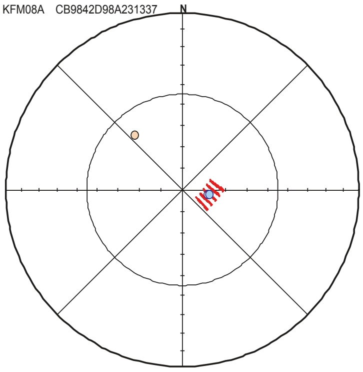
KFM08A F45842D98A230332



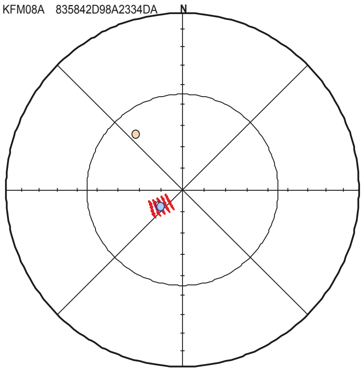
KFM08A A51842D98A230A64



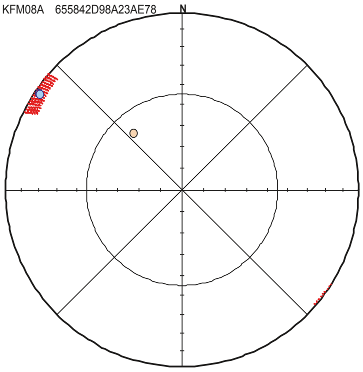
KFM08A CB9842D98A231337

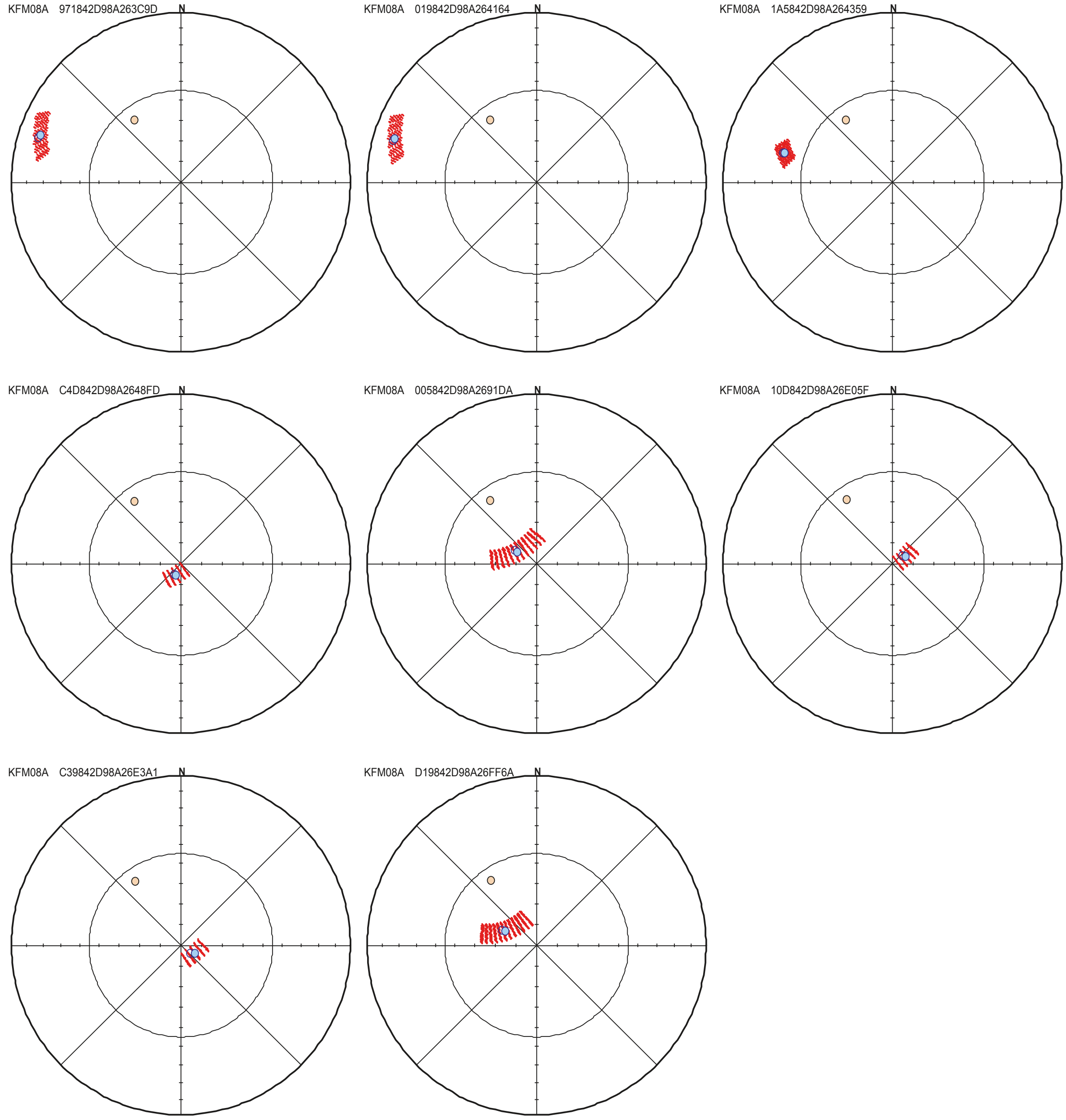


KFM08A 835842D98A2334DA



KFM08A 655842D98A23AE78



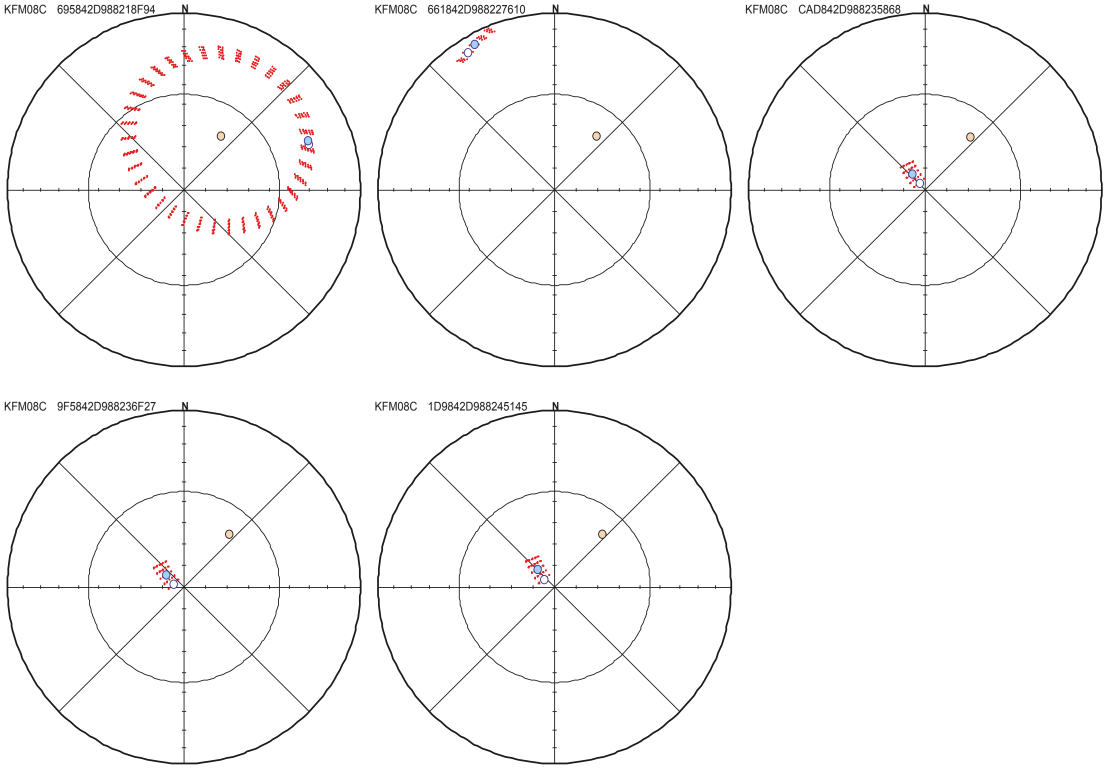


4.1.11 KFM08C

Below follow the sample space of uncertainty for the 5 PFL fractures in KFM08C. The uppermost PFL fracture has full beta uncertainty and hence should be paid extra attention, see Table 4-11. The uncertainty sample space shows that the fracture can be steep and south east striking as well as sub horizontal.

Table 4-11. Fracture in KFM08C needing extra attention.

Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
695842D988218F94	X		86.3	1.6

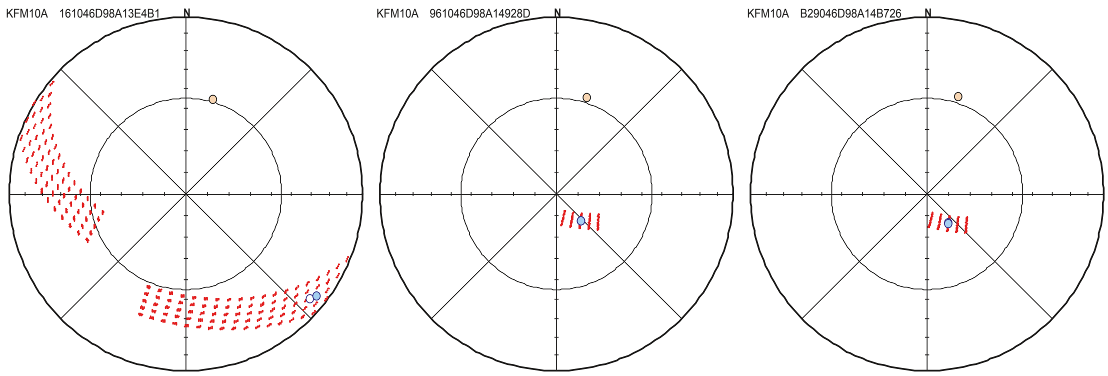


4.1.12 KFM10A

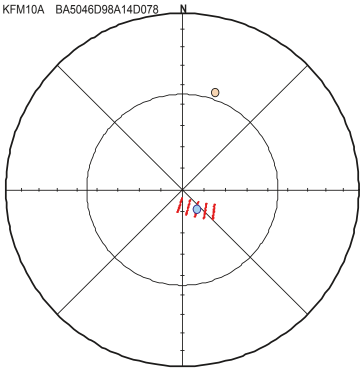
Below follow the sample space of uncertainty for the 14 PFL fractures in KFM10A. Extra attention should be paid to the thre fractures listed in Table 4-12. These fractures have a large uncertainty, i.e. $\Omega > 10°$, implying they can have an alternative interpretation of orientation compared to the best estimate orientation that is found in the table p_fract_core in /Sicada 2007/.

Table 4-12. Fractures in KFM10A needing extra attention.

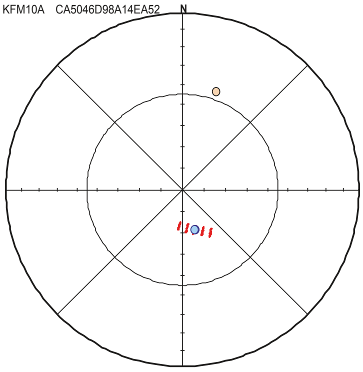
Feature ID	Large uncertainty	Large orientation change	Uncertainty dihedral angle (°)	Orientation change dihedral angle (°)
161046D98A13E4B1	×		74.2	3.0
21D046D98A14FEFE	×		12.6	0.4
1DD046D98A157F77	×		45.6	0.4



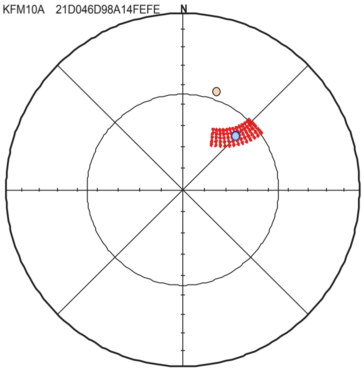
KFM10A BA5046D98A14D078



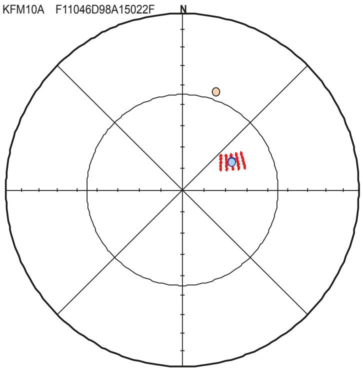
KFM10A CA5046D98A14EA52



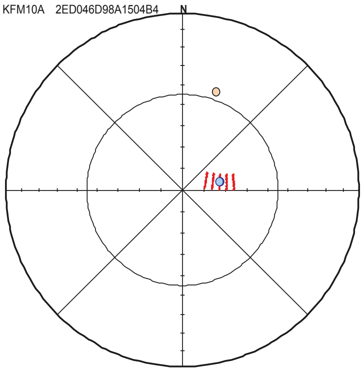
KFM10A 21D046D98A14FEFE



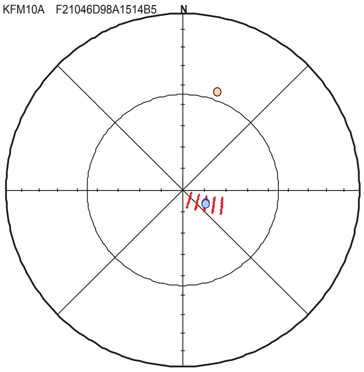
KFM10A F11046D98A15022F



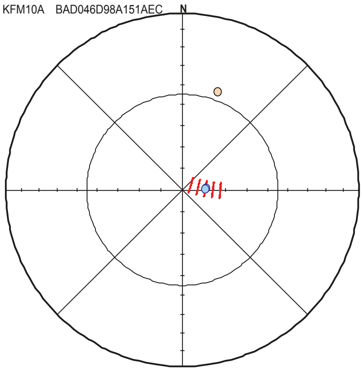
KFM10A 2ED046D98A1504B4



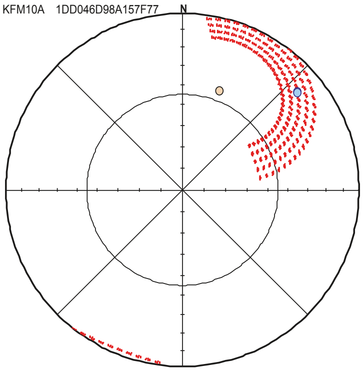
KFM10A F21046D98A1514B5



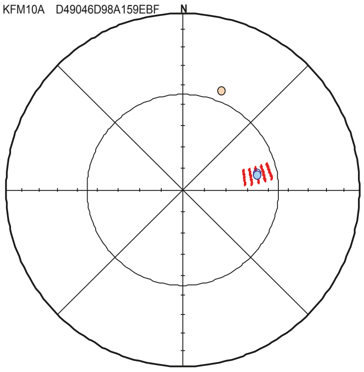
KFM10A BAD046D98A151AEC



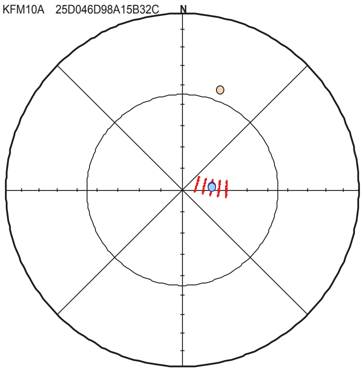
KFM10A 1DD046D98A157F77



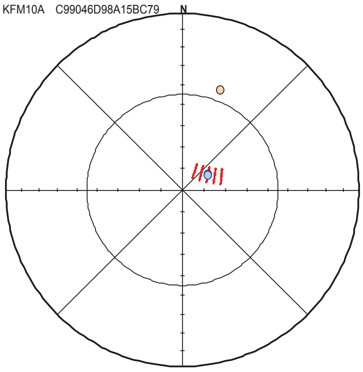
KFM10A D49046D98A159EBF



KFM10A 25D046D98A15B32C



KFM10A C99046D98A15BC79



4.2 Orientation uncertainty versus transmisivity

The transmissivity distribution in different fracture sets is one of the fundamentals in developing a hydrogeological DFN model. It is of great importance that the orientation of the high transmissive fractures are certain to be able to judge which fracture set they belong.

In Figure 4-1 is shown a cross plot of the transmissivity value of all PFL fractures versus the maximum uncertainty of the orientation, Ω. There are 10 fractures, c. 4%, that have an uncertainty larger than 30º. These fractures' uncertainty, transmissivity and Feature ID are listed in Table 4-13 to help the reader to find the corresponding uncertainty plot in Section 4.1.1 to 4.1.12.

Of the 5 highest transmissivities there is one fracture having a high uncertainty, Ω = 86º, due to lack of orientation of the Bips image, see fracture 695842D988218F94, upper left stereonet, in Section 4.1.11. That is, the orientation given in /Sicada 2007/ indicates that it is steep, striking east. However, due to the large uncertainty, it could actually be sub horizontal with equal probability.

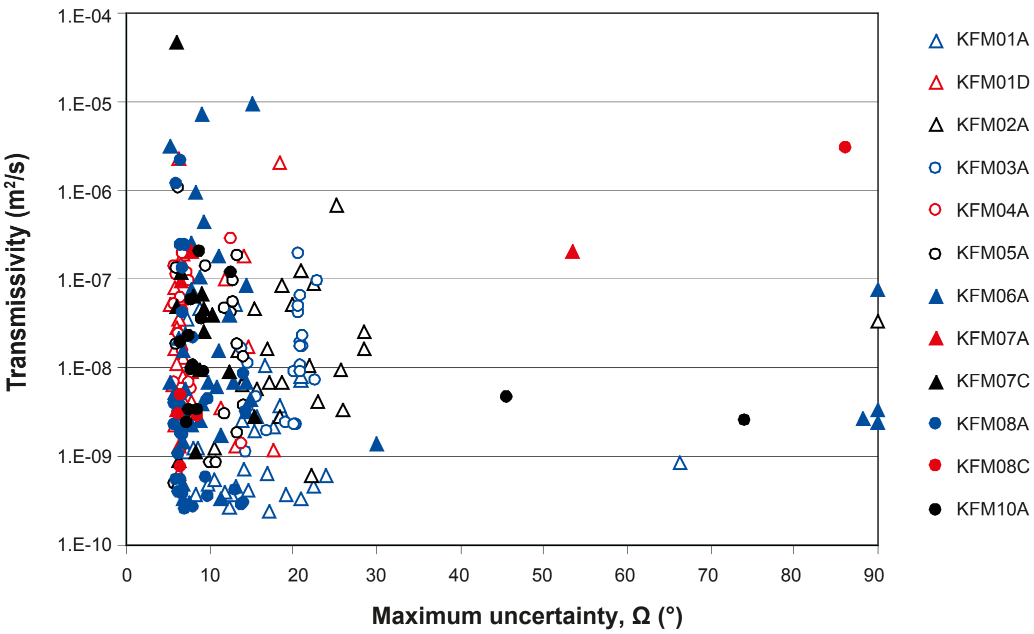


Figure 4-1. *Cross plot of the maximum uncertainty and transmissivity.*

Table 4-13. The Feature ID of the 10 PFL fractures with the largest uncertainty in orientation.

Borehole name	Fracture feature ID	Uncertainty, Ω (°)	Transmissivity (m^2/s)
KFM01A	C61142D98A22359B	66.3	8.59E–10
KFM02A	615242D98A318EB2	90.0	3.28E–08
KFM06A	09D642D98A318F3F	89.9	2.38E–09
KFM06A	415642D98A319EF2	88.2	2.69E–09
KFM06A	589642D98A31AF7E	90.0	7.60E–08
KFM06A	A2D642D98A31B325	90.0	3.40E–09
KFM07A	8E9742D98A2DEF3C	53.5	2.00E–07
KFM08C	695842D988218F94	86.3	2.95E–06
KFM10A	161046D98A13E4B1	74.2	2.61E–09
KFM10A	1DD046D98A157F77	45.6	4.74E–09

5 Summary

It was possible to connect all specified 251 PFL fractures with the corresponding fracture in the current data in Sicada and hence tag them with Feature ID. This provided a possibility to do the analysis of changes in orientation and calculate the uncertainty for the specified PFL fractures.

The changes in orientation between the pre 2007 data and the current data can be large, up to 40º. The changes are largest in the three first drilled boreholes, i.e. KFM01A, -2A and -3A, which are steeply inclined about 85°. In the remaining boreholes in the study the change in orientation is less than 6º.

The sample space for orientation uncertainty is plotted for each fracture to be able to see possible orientation for each fracture. About half, 120 of 251, of the fractures have an uncertainty larger than 10° and should be paid extra attention. Out of these 120 fractures there are ten that have an uncertainty in orientation that is larger than 30º, and hence need to be handled with care since they have the possibility to belong to another fracture set.

There are twelve fractures in the three first drilled boreholes, i.e. KFM01A, -2A and -3A, that have larger change in orientation than the maximum uncertainty, Ω. This implies that the pre 2007 orientation is not valid as a possible current orientation on the 90^{th} percentile and thus should be paid extra attention.

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Sicada, 2007. Sicada_07_239.

Stephens M B, Isaksson H, Simeonov A, 2007. Geology – Site descriptive modelling Forsmark stage 2.2. SKB R-07-45, Svensk Kärnbränslehantering AB.

Table of the 251 PFL fractures studied

Table of PFL anomalies connected to Feature ID in /Sicada 2007/.

The first nine Columns is processed excerption from /Forsman et al 2004, 2006 and Teurneau et al. 2007/ and used in /Follin et al. 2007/. The next seven, shaded in grey, are excerption from the table p_fract_core /Sicada 2007/ and the last four columns are calculated using the algorithm in Appendix 2. The column "Orientation change" is the dihedral angle between the fracture orientation in the pre 2007 and current data. The "max uncertainty" column is the dihedral angle between the most probable orientation and the point in the 90th percentile sample space which is the furthest away. Note that the maximum possible value is 90º. The column "Difference between data sets" shows which parameter that was not equal when comparing pre 2007 and current data. The last column "multiple possible fractures" indicates if there where a possibility to choose between more than 1 fracture in the table p_fract_core /Sicada 2007/.

Idcode	PFL-NO	B/U	O/PO/S	C/ Pr/Po	Aperture	Alpha	Secup	T PFL–F	FEATURE_ID	ALPHA	UNCERT_ ALPHA	BETA	UNCERT_ BETA	STRIKE	DIP	Orientation change	Max uncertainty	Difference between data sets	Multiple possible fractures
KFM01A	1	1	1	1	1	85.1	105.25	1.11E–09	E85142D98A219B1F	85.1	3.6	322.3	37.0	91.4	3.6	3.3	7.2	–	
KFM01A	2	1	1	2	0.5	76.2	107.07	4.68E–10	E7D142D98A21A23C	76.2	3.6	290.7	37.0	120.3	12.9	8.7	13.1	–	
KFM01A	3	1	1	1	1	77.6	113.66	2.53E–09	331142D98A21BBF9	77.6	3.6	255.7	44.0	87.8	15.0	3.0	13.9	–	
KFM01A	4	1	1	1	2	84.9	115.09	3.57E–08	B29142D98A21C190	84.9	3.6	35.0	40.0	334.5	3.4	1.7	7.4	–	
KFM01A	5	1	1	1	1	77.0	118.17	5.31E–08	485142D98A21CD95	77.0	3.6	269.7	39.0	99.3	14.3	8.7	13.2	–	
KFM01A	6	1	1	1	1	68.1	121.63	3.20E–09	3E5142D98A21DB1C	68.1	3.6	311.9	39.0	152.0	18.4	14.7	18.7	–	
KFM01A	7	1	1	1	1.5	69.0	122.42	3.69E–09	945142D98A21DE31	69.0	3.6	316.8	40.0	157.0	17.0	14.1	18.4	–	
KFM01A	8	1	1	2	0.5	84.6	123.10	1.25E–09	285142D98A21E0DD	84.6	3.6	299.8	40.0	87.6	5.8	3.9	8.0	–	
KFM01A	9	1	1	2	0.5	60.8	123.65	4.67E–10	001142D98A21E306	60.8	3.6	335.3	38.0	183.2	23.8	19.0	22.5	–	
KFM01A	10	1	1	1	1	71.5	127.89	1.97E–09	139142D98A21F38F	71.5	3.6	32.5	37.0	259.4	13.7	11.7	15.3	–	
KFM01A	11	2	2	1	2	6.4	128.14	6.15E–10	951142D98A21F490	6.4	1.4	337.6	19.0	190.7	78.0	37.3	24.0	–	
KFM01A	12	1	1	1	2	59.2	144.79	8.59E–10	C61142D98A22359B	59.2	3.0	42.1	180.0	262.2	26.4	15.0	66.3	–	
KFM01A	13	1	1	1	1	6.7	146.38	7.24E–09	AF5142D98A223BCF	6.7	1.4	339.0	16.0	190.3	77.4	21.6	21.0	–	
KFM01A	14	1	1	1	1	74.6	147.36	7.73E–09	01D142D98A223F9E	74.6	3.6	284.4	37.0	112.5	15.1	5.5	14.2	–	
KFM01A	15	1	1	1	2	6.6	148.87	8.22E–09	AB5142D98A224585	6.6	1.4	18.3	16.0	230.3	77.3	21.3	21.0	–	
KFM01A	16	1	1	1	3	68.5	158.22	1.06E–08	5D5142D98A226A0C	68.5	3.6	290.8	33.0	125.7	20.1	7.9	16.6	–	
KFM01A	17	1	1	1	1	78.4	159.03	4.91E–10	FED142D98A226D33	78.4	3.6	17.8	33.0	249.5	5.8	4.3	9.7	–	
KFM01A	18	1	1	1	1	49.2	161.69	7.36E–10	681142D98A22779E	49.2	3.0	279.8	13.6	124.0	40.1	13.9	14.1	–	
KFM01A	19	1	1	2	0.5	72.5	162.66	4.17E–10	7E5142D98A227B60	72.5	3.6	266.8	33.0	99.3	19.0	6.4	14.5	–	
KFM01A	20	1	1	3	0.5	6.1	174.24	2.45E–10	911142D98A22A8A1	6.1	1.4	7.0	12.0	219.0	77.4	21.2	17.1	–	
KFM01A	21	1	1	1	1	81.4	177.34	1.22E–09	9B5142D98A22B4B7	81.4	3.6	330.1	33.0	133.5	4.4	3.2	8.5	–	
KFM01A	22	1	1	1	4	81.0	177.91	4.70E–08	F15142D98A22B6FA	81.0	3.6	329.1	33.0	135.9	4.7	3.3	8.7	–	
KFM01A	23	1	1	1	2	68.8	187.34	2.82E–09	485142D98A22DBCD	68.8	3.6	324.3	33.0	163.1	16.2	7.7	15.6	–	
KFM01A	24	1	1	3	0.5	65.5	226.32	3.68E–10	E85142D98A237410	65.5	3.6	192.5	36.0	44.4	31.2	20.2	19.1	–	
KFM01A	25	1	1	3	0.5	11.3	264.86	3.41E–10	C41142D98A240A9E	11.3	1.4	177.3	16.0	32.5	85.9	22.0	20.8	–	
KFM01A	28	1	1	1	3	69.1	291.63	6.33E–10	311142D98A247332	69.1	3.6	268.0	34.0	104.5	22.3	8.9	16.9	–	
KFM01A	29	1	1	1	1	78.3	305.79	5.59E–10	239142D98A24AA7E	78.3	3.6	308.2	33.0	124.6	9.2	3.9	10.6	–	
KFM01A	30	1	1	1	1.5	66.4	315.53	2.19E–09	931142D98A24D08B	66.4	3.6	292.5	33.0	130.4	21.8	7.6	17.7	–	
KFM01A	31	1	1	1	2	82.5	319.35	3.64E–10	CC5142D98A24DF79	82.5	3.6	307.6	33.0	99.5	6.6	2.5	8.4	–	
KFM01A	32	1	1	1	2	76.1	324.69	2.67E–10	CA1142D98A24F44E	76.1	3.6	290.8	34.0	114.7	13.2	4.6	12.4	–	
KFM01A	33	1	1	1	1	76.2	331.62	3.64E–10	3B5142D98A250F64	76.2	3.6	247.7	34.0	80.9	18.1	4.8	12.7	–	
KFM01A	34	1	1	1	7	76.4	361.92	3.88E–10	099142D98A2585BD	76.4	3.6	313.6	34.0	133.9	9.9	4.9	11.7	–	

Idcode	PFL-NO	B/U	O/PO/S	C/ Pr/Po	Aperture	Alpha	Secup	T PFL–F	FEATURE_ID	ALPHA	UNCERT_ ALPHA	BETA	UNCERT_ BETA	STRIKE	DIP	Orientation change	Max uncertainty	Difference between data sets	Multiple possible fractures
KFM01D	1	1	1	1	3	58.5	106.07	5.05E–08	E71142D98F119E54	58.5	3.0	358.0	7.6	141.7	3.7	0.1	5.4	–	
KFM01D	2	1	1	1	1.5	47.7	120.86	1.66E–07	571142D98F11D81C	47.7	3.0	345.0	7.6	246.9	11.8	0.2	6.5	–	
KFM01D	3	1	1	1	2.5	47.0	121.86	6.11E–08	EE5142D98F11DBFF	47.0	3.0	344.0	7.6	247.0	12.8	0.2	6.5	–	
KFM01D	4	1	1	1	2	50.1	122.72	3.56E–08	EC5142D98F11DF5F	50.1	3.0	339.0	7.6	227.4	13.6	0.2	6.3	–	multiple
KFM01D	5	1	1	1	1	48.7	125.04	8.08E–09	765142D98F11E870	48.7	3.0	352.0	8.6	263.0	7.8	0.1	6.9	–	
KFM01D	6	1	1	1	2	39.7	125.52	9.19E–09	351142D98F11EA4D	39.7	3.0	337.0	8.6	250.3	21.5	0.1	7.9	–	
KFM01D	7	1	1	2	1	49.9	125.76	1.35E–08	6B1142D98F11EB3D	49.9	3.0	334.0	8.6	221.8	16.5	0.1	6.9	–	
KFM01D	8	1	1	2	0.5	53.4	126.49	1.34E–09	F9D142D98F11EE1A	53.4	3.0	355.0	8.6	238.7	3.2	0.1	6.4	–	
KFM01D	9	1	1	1	1.5	53.3	128.04	6.59E–10	F29142D98F11F42C	53.3	3.0	5.0	8.6	10.2	3.3	0.1	6.4	–	multiple
KFM01D	10	1	1	1	1	61.1	129.45	1.77E–08	EC9142D98F11F9AE	61.1	3.6	357.0	28.0	138.1	6.5	0.2	14.7	–	
KFM01D	11	1	1	1	1	51.3	131.22	1.13E–08	FC1142D98F12008F	51.3	3.0	346.0	7.6	232.1	9.1	0.2	6.1	–	multiple
KFM01D	12	1	1	2	0.5	51.8	131.41	1.90E–08	285142D98F120155	51.8	3.0	329.0	7.6	211.6	18.6	0.1	6.2	–	
KFM01D	13	1	1	2	0.5	66.3	142.72	1.19E–09	609142D98F122D81	66.3	3.6	23.0	40.0	90.6	16.0	0.2	17.6	–	
KFM01D	14	1	1	2	0.5	59.5	143.13	3.59E–09	D0D142D98F122F1D	59.5	3.0	15.0	20.6	72.0	9.4	0.2	11.5	–	
KFM01D	15	1	1	1	2	64.9	144.77	2.02E–06	819142D98F123581	64.9	3.6	26.0	40.0	84.0	16.4	0.2	18.4	–	
KFM01D	16	1	1	1	2	52.2	145.48	2.32E–07	DB9142D98F123847	52.2	3.0	9.0	9.6	13.9	5.9	0.2	7.1	–	
KFM01D	17	1	1	1	2	58.3	147.86	2.30E–06	415142D98F124192	58.3	3.0	24.0	9.6	60.2	13.6	0.2	6.4	–	
KFM01D	18	1	1	1	1	44.8	150.78	1.91E–07	E01142D98F124CFF	44.8	3.0	22.0	7.6	9.2	17.2	0.3	6.8	–	
KFM01D	19	1	1	1	0.5	44.9	151.80	1.48E–07	A11142D98F1250F4	44.9	3.0	6.0	7.6	329.1	10.5	0.2	6.6	confidence	
KFM01D	20	1	1	2	0.5	44.7	153.63	3.23E–09	321142D98F12581F	44.7	3.0	345.0	7.6	254.7	13.8	0.1	6.7	–	
KFM01D	21	1	1	1	1	37.0	154.73	4.07E–09	6B1142D98F125C69	37.0	3.0	82.0	7.6	53.2	56.3	0.2	7.7	–	
KFM01D	22	1	1	1	1	46.9	157.34	2.36E–08	F29142D98F12669A	46.9	3.0	347.0	7.6	253.0	11.2	0.2	6.5	–	multiple
KFM01D	23	1	1	1	3	47.7	158.30	4.46E–09	8D9142D98F126A5A	47.7	3.0	80.0	7.6	61.8	47.9	0.1	6.9	–	
KFM01D	24	1	1	2	0.5	55.5	193.96	6.53E–09	031142D98F12F5AB	55.5	3.0	0.0	7.6	124.3	1.4	0.3	5.6	–	
KFM01D	25	1	1	1	1	64.1	263.70	1.30E–09	631142D98F140613	64.1	3.6	9.0	27.0	105.5	12.3	0.1	13.2	–	
KFM01D	26	1	1	1	2	67.7	306.78	9.89E–08	1D5142D98F14AE5F	67.7	3.6	350.0	27.0	136.4	17.1	0.3	11.8	–	multiple
KFM01D	27	1	1	1	3	61.6	316.22	1.83E–07	7CD142D98F14D33F	61.6	3.6	10.0	27.0	100.4	11.8	0.2	14.2	–	
KFM01D	28	1	1	1	1	51.6	352.42	3.42E–09	355142D98F15609F	51.6	3.0	7.0	7.6	48.8	4.5	0.3	6.0	–	multiple
KFM01D	29	1	1	1	1.5	53.3	354.26	2.22E–09	631142D98F1567D1	53.3	3.0	4.0	7.6	83.7	3.7	0.4	5.8	–	multiple
KFM01D	30	1	1	1	1	54.7	368.50	1.60E–08	4C1142D98F159F77	54.7	3.0	13.0	7.6	67.6	9.1	0.6	5.8	–	
KFM01D	31	1	1	1	2	53.3	376.86	8.21E–08	5A1142D98F15C01A	53.3	3.0	4.0	7.6	87.6	4.1	0.5	5.8	–	
KFM01D	32	1	1	2	0.5	50.7	380.97	2.90E–08	F31142D98F15D028	50.7	3.0	17.0	7.6	44.0	10.9	0.4	6.2	–	

Idcode	PFL-NO	B/U	O/PO/S	C/ Pr/Po	Aperture	Alpha	Secup	T PFL–F	FEATURE_ID	ALPHA	UNCERT_ ALPHA	BETA	UNCERT_ BETA	STRIKE	DIP	Orientation change	Max uncertainty	Difference between data sets	Multiple possible fractures
KFM01D	33	1	1	1	1	49.8	430.30	6.23E–08	515142D98F1690D9	49.8	3.0	20.0	7.6	38.9	12.8	0.5	6.3	–	
KFM01D	34	1	1	1	1	45.1	569.34	1.59E–08	099142D98F18AFFF	45.1	3.0	29.0	7.6	36.0	20.0	0.5	6.8	–	multiple
KFM02A	1	1	1	2	1	28.7	102.07	3.28E–08	615242D98A318EB2	28.7	1.4	118.0	180.0	311.4	63.1	9.8	90.0	–	
KFM02A	16	1	1	1	1	69.7	122.15	1.27E–07	869242D98A31DD24	69.7	3.6	289.9	51.0	112.2	19.3	8.0	20.9	–	
KFM02A	17	1	1	2	1	78.7	124.85	1.52E–08	E8D242D98A31E7B6	78.7	3.6	326.7	55.0	144.7	8.3	6.1	13.4	–	
KFM02A	18	1	3	2	0	66.9	125.85	4.26E–09	2FD242D98A31EB97	66.9	3.6	352.9	51.0	184.2	19.2	11.8	22.8	–	
KFM02A	19	1	1	2	1	54.6	129.62	1.04E–08	D45242D98A31FA52	54.6	3.0	315.3	31.6	143.9	32.7	19.2	21.9	–	
KFM02A	20	1	1	1	2	63.6	136.95	9.42E–09	73D242D98A3216F6	63.6	3.6	340.1	51.0	170.6	22.6	16.4	25.7	–	
KFM02A	42	1	1	2	1	61.7	216.58	6.77E–07	D21242D98A334E06	61.7	3.6	222.7	45.0	60.7	31.8	11.0	25.1	–	
KFM02A	43	1	3	2	0	11.0	218.92	1.68E–08	26D242D98A335724	11.0	1.4	156.1	24.0	359.5	83.3	24.6	28.5	–	
KFM02A	44	1	1	2	2	53.7	227.35	8.46E–08	A1D242D98A337817	53.7	3.0	335.8	25.6	176.0	32.1	19.5	18.6	–	
KFM02A	76	1	1	2	1	48.1	410.03	6.85E–09	D71242D98A3641AC	48.1	3.0	155.2	21.6	3.7	46.6	1.0	18.8	–	
KFM02A	77	1	1	2	1	53.6	410.50	1.61E–08	FB5242D98A364387	53.6	3.0	165.5	21.6	13.4	41.4	1.1	16.9	–	
KFM02A	78	1	1	1	2.5	51.7	415.18	5.32E–08	0FD242D98A3655CC	51.7	3.0	153.4	25.6	2.3	42.9	2.6	20.0	–	
KFM02A	93	1	1	2	1	75.2	446.64	6.35E–09	E7D242D98A36D0AE	75.2	3.6	228.5	41.0	69.9	18.6	4.8	13.8	–	
KFM02A	94	1	3	2	0	79.6	447.30	1.27E–09	5E5242D98A36D340	79.6	3.6	222.9	41.0	62.3	14.6	3.7	10.6	–	
KFM02A	95	1	3	2	0	62.8	452.56	8.89E–08	E65242D98A36E7CC	62.8	3.6	273.9	41.0	117.7	27.3	9.0	22.4	–	
KFM02A	96	1	1	2	1	72.8	452.97	4.74E–08	80D242D98A36E96A	72.8	3.6	253.0	41.0	92.5	19.3	6.2	15.4	–	
KFM02A	97	1	1	2	1	72.6	453.45	5.89E–09	935242D98A36EB4B	72.6	3.6	255.2	41.0	94.6	19.3	6.3	15.6	–	
KFM02A	98	1	1	2	1	70.5	458.16	6.95E–09	B45242D98A36FDB4	70.5	3.6	175.7	41.0	30.7	24.7	7.7	17.1	–	
KFM02A	99	2	2	1	1	12.4	461.00	2.60E–08	231242D98A3708CC	12.4	1.4	216.0	24.0	69.0	81.8	18.7	28.4	–	
KFM02A	100	1	3	2	0	34.5	461.66	3.33E–09	C49242D98A370B5C	34.5	3.0	231.6	25.6	82.6	58.8	15.7	26.0	–	
KFM02A	101	2	2	1	1	65.1	463.72	6.16E–10	B81242D98A371364	65.1	3.6	58.2	45.0	281.7	22.5	6.5	22.3	–	multiple
KFM02A	102	2	2	1	1	70.4	466.99	2.90E–09	23D242D98A37202D	70.4	3.6	114.0	45.0	338.3	22.3	5.0	18.5	–	
KFM03A	1	1	1	1	2	57.0	106.26	1.13E–08	E25342D98A219F18	57.0	3.0	273.5	17.6	64.2	33.0	8.6	14.5	–	
KFM03A	2	1	3	2	0	56.3	112.95	3.49E–09	D45342D98A21B936	56.3	3.0	299.6	17.6	90.7	31.9	7.9	14.6	–	
KFM03A	3	2	2	1	1	12.5	120.22	6.52E–08	DA5342D98A21D597	12.5	1.4	319.7	16.0	115.2	74.4	13.1	20.8	–	
KFM03A	4	1	1	3	1	5.5	122.68	1.69E–08	6E5342D98A21DF38	5.5	1.4	148.4	16.0	304.7	88.0	13.1	21.1	–	
KFM03A	5	1	1	2	1	20.0	126.42	8.83E–09	24D342D98A21EDD2	20.0	1.4	150.0	16.0	306.4	73.6	11.6	20.3	–	
KFM03A	6	1	1	3	1	61.0	129.87	9.55E–08	339342D98A21FB4F	61.0	3.6	288.5	37.0	76.7	27.9	5.6	22.9	–	
KFM03A	7	2	2	1	1	72.8	130.53	4.56E–09	0D5342D98A21FDDF	72.8	3.6	259.5	37.0	42.7	18.4	3.4	15.6	–	
KFM03A	8	1	3	2	0	70.0	149.48	1.88E–09	5FD342D98A2247EC	70.0	3.6	306.0	37.0	91.4	17.8	3.4	16.9	–	

Idcode	PFL-NO	B/U	O/PO/S	C/ Pr/Po	Aperture	Alpha	Secup	T PFL–F	FEATURE_ID	ALPHA	UNCERT_ ALPHA	BETA	UNCERT_ BETA	STRIKE	DIP	Orientation change	Max uncertainty	Difference between data sets	Multiple possible fractures
KFM03A	9	1	3	2	0	27.2	175.10	2.42E–09	A21342D98A22ABF8	27.2	1.4	166.0	16.0	323.9	67.1	6.4	19.2	–	
KFM03A	10	2	2	1	1	32.3	313.19	2.30E–09	FE1342D98A24C762	32.3	3.0	281.4	17.6	92.6	56.9	6.6	20.5	–	
KFM03A	11	1	3	2	0	31.2	352.63	2.30E–09	89D342D98A256176	31.2	3.0	28.1	17.6	212.1	54.3	11.3	20.2	–	
KFM03A	32	1	3	2	0	85.1	408.87	1.65E–08	3AD342D98A263D27	59.3	3.0	258.9	17.6	80.6	32.1	10.5	13.9	alpha	multiple
KFM03A	33	2	2	1	1	53.9	409.57	3.58E–09	589342D98A263FE5	53.9	3.0	16.8	17.6	209.7	31.1	11.9	14.4	–	multiple
KFM03A	37	1	1	1	1	61.3	460.39	7.08E–09	855342D98A27066B	61.3	3.6	245.3	37.0	70.0	31.3	7.1	22.8	–	
KFM03A	38	1	1	2	1	64.3	498.19	1.94E–08	9F1342D98A279A0F	64.3	3.6	246.2	37.0	67.9	28.3	5.1	21.0	–	
KFM03A	39	1	1	2	1	74.1	513.50	1.09E–09	60D342D98A27D5E0	74.1	3.6	214.1	37.0	38.2	20.8	3.6	14.3	–	multiple
KFM03A	40	1	1	1	2	64.2	515.34	1.05E–08	56D342D98A27DD10	64.2	3.6	238.2	37.0	62.4	29.1	5.8	21.0	–	
KFM03A	41	1	1	2	1	64.2	531.00	2.25E–08	6F9342D98A281A35	64.2	3.6	261.7	37.0	85.9	27.1	6.5	21.1	–	multiple
KFM03A	48	2	2	1	1.5	15.8	981.54	1.89E–07	AE5342D98A2EFA28	15.8	1.4	200.8	16.0	50.6	81.0	22.3	20.6	–	
KFM03A	49	1	1	1	5	13.3	981.59	8.90E–09	D19342D98A2EFA56	13.3	1.4	202.8	16.0	52.7	83.4	22.5	20.8	–	
KFM03A	50	1	1	1	2	16.1	987.96	4.22E–08	171342D98A2F1339	16.1	1.4	224.7	16.0	74.1	79.1	22.2	20.7	–	
KFM03A	51	1	1	1	2.5	16.1	989.02	4.85E–08	BA9342D98A2F175F	16.1	1.4	229.7	16.0	79.0	78.7	22.1	20.7	–	
KFM03A	52	2	2	1	1	12.6	989.06	1.76E–08	F29342D98A2F1783	12.6	1.4	229.7	16.0	79.3	82.2	22.4	20.9	–	
KFM04A	1	1	1	2	0.5	54.7	109.66	1.39E–07	719442D98A61AC59	54.7	3.0	359.3	7.6	307.4	8.2	1.0	5.8	–	
KFM04A	37	1	1	1	1	25.5	176.65	6.09E–08	155442D98A62B205	25.5	1.4	153.0	6.0	285.3	89.6	0.3	6.5	–	multiple
KFM04A	38	1	1	1	0	42.5	177.22	1.16E–07	811442D98A62B442	42.5	3.0	208.0	7.6	150.6	73.6	0.3	7.4	aperture	
KFM04A	39	1	1	2	0	54.9	178.43	2.40E–08	23D442D98A62B8F9	54.9	3.0	291.0	7.6	198.1	35.2	0.1	6.2	aperture	
KFM04A	40	1	1	1	0	65.8	179.49	2.80E–07	0C1442D98A62BD21	65.8	3.6	326.0	27.0	188.4	15.5	0.1	12.5	aperture	
KFM04A	41	1	1	1	0	55.7	181.41	5.28E–08	149442D98A62C4A1	55.7	3.0	345.0	7.6	249.2	9.6	0.3	5.8	aperture	
KFM04A	42	1	1	1	0	34.6	185.92	5.92E–09	101442D98A62D63E	34.6	3.0	312.0	7.6	238.7	40.3	0.2	7.8	aperture	multiple
KFM04A	43	1	1	1	0	47.6	186.55	4.59E–09	341442D98A62D8B3	47.6	3.0	341.0	7.6	262.7	17.5	0.3	6.6	aperture	
KFM04A	44	1	1	1	0	37.9	190.28	9.45E–08	335442D98A62E743	37.9	3.0	324.1	7.6	249.6	32.2	0.3	7.5	aperture	
KFM04A	45	1	1	2	0.5	44.2	190.92	4.39E–08	2B5442D98A62E9CC	44.2	3.0	350.4	7.6	287.0	18.0	0.5	6.8	–	multiple
KFM04A	46	1	1	1	1	45.1	191.48	1.90E–07	A31442D98A62EBF9	45.1	3.0	343.6	7.6	271.3	18.7	0.5	6.8	aperture	
KFM04A	47	1	1	1	0.5	52.1	192.90	1.09E–07	60D442D98A62F185	52.1	3.0	348.2	7.6	269.0	11.1	0.8	6.1	aperture	
KFM04A	48	1	1	2	0.5	56.1	194.57	6.71E–09	E79442D98A62F80D	56.1	3.0	318.8	7.6	214.5	21.6	1.1	5.9	–	multiple
KFM04A	56	1	1	1	1	16.7	256.66	1.52E–08	809442D98A63EA94	16.7	1.4	104.9	6.0	60.8	82.9	1.9	6.8	–	
KFM04A	57	1	1	2	0.5	39.4	272.89	6.73E–09	9AD442D98A6429F8	39.4	3.0	193.0	7.6	139.8	80.6	1.7	7.6	–	
KFM04A	70	1	1	2	0.5	62.6	519.19	1.41E–09	4D9442D98A67EC19	62.6	3.6	352.0	27.0	150.0	10.3	0.3	13.7	–	
KFM05A	7	1	1	2	1	59.0	115.96	5.00E–10	431542D98A11C4FC	59.3	3.0	7.1	8.6	69.2	3.7	0.7	5.7	–	

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KFM05A	8	1	1	1	1	67.0	116.48	4.18E–08	179542D98A11C700	66.6	3.6	19.0	28.0	127.7	10.4	0.6	12.6	–	multiple
KFM05A	9	1	1	1	2	69.0	119.65	4.77E–08	B4D542D98A11D35E	68.5	3.6	13.0	28.0	144.5	9.9	0.6	11.8	–	
KFM05A	10	1	1	1	1	66.0	120.21	5.41E–08	07D542D98A11D58F	66.1	3.6	2.0	28.0	165.0	5.9	0.5	12.7	–	
KFM05A	11	1	1	1	2	55.0	120.57	1.06E–06	43D542D98A11D6F9	55.3	3.0	20.0	8.6	66.5	11.7	0.5	6.4	–	multiple
KFM05A	12	1	1	1	1	64.0	121.83	1.85E–08	735542D98A11DBE3	64.4	3.6	8.0	28.0	134.2	5.5	0.5	13.4	–	
KFM05A	13	1	1	1	1	64.0	124.11	1.86E–07	875542D98A11E4D3	64.2	3.6	46.0	27.0	112.8	21.3	0.7	13.3	–	
KFM05A	14	1	1	1	1	65.0	124.36	9.59E–08	DB1542D98A11E5C6	64.6	3.6	20.0	27.0	116.0	10.1	0.6	12.9	–	
KFM05A	15	1	1	1	1	63.0	125.91	1.78E–09	1ED542D98A11EBD2	63.1	3.6	11.0	27.0	115.4	5.9	0.6	13.5	–	
KFM05A	16	1	1	2	1	62.0	130.78	3.83E–09	6BD542D98A11FEE1	61.8	3.6	24.0	27.0	100.5	11.7	0.6	14.0	–	
KFM05A	17	1	3	2	0	72.0	131.96	8.61E–10	619542D98A120379	72.4	3.6	61.0	27.0	136.2	25.9	0.3	10.0	–	
KFM05A	18	1	1	1	1	51.0	142.24	4.45E–10	151542D98A122B9C	50.9	3.0	4.0	7.6	9.5	9.3	0.1	6.2	–	
KFM05A	19	1	1	1	3	54.0	149.10	2.86E–09	099542D98A12466B	54.1	3.0	131.0	7.6	143.0	59.6	0.6	7.0	–	
KFM05A	20	1	1	1	3	57.0	163.61	1.29E–07	5FD542D98A127F1B	57.4	3.0	53.2	7.6	103.4	27.2	1.3	6.1	–	
KFM05A	21	1	1	2	1	68.0	166.20	3.04E–09	735542D98A12893B	67.5	3.6	23.3	27.0	132.3	13.0	0.6	11.9	–	
KFM05A	22	1	1	2	1	62.0	166.97	1.30E–08	6B9542D98A128C3A	62.0	3.6	34.4	27.0	107.9	16.8	1.1	14.0	–	
KFM05A	23	1	1	2	1	70.0	168.49	8.55E–10	D21542D98A129225	69.9	3.6	49.7	27.0	132.2	22.8	1.0	10.9	–	
KFM05A	24	1	1	1	1	74.0	175.24	1.41E–07	EF9542D98A12AC8A	73.6	3.6	6.8	27.0	166.4	14.3	0.7	9.5	–	
KFM05A	25	1	1	1	4	56.0	263.82	1.86E–08	0AD542D98A14068F	55.9	3.0	30.0	7.6	89.6	16.4	2.3	5.9	–	multiple
KFM06A	1	1	1	2	1	38.0	102.21	2.38E–09	09D642D98A318F3F	37.9	7.4	323.0	180.0	145.2	32.2	0.3	89.9	–	
KFM06A	2	1	1	1	1	25.0	106.23	2.69E–09	415642D98A319EF2	24.5	1.4	158.0	180.0	188.3	86.7	1.3	88.2	–	
KFM06A	3	1	1	2	1	77.0	109.22	1.37E–09	A05642D98A31AAA3	77.2	3.6	302.0	180.0	54.7	25.2	0.6	29.9	–	
KFM06A	4	1	1	1	4	46.0	110.46	7.60E–08	589642D98A31AF7E	45.9	3.0	165.0	180.0	17.8	73.2	1.1	90.0	–	
KFM06A	5	1	1	1	5	37.0	111.40	3.40E–09	A2D642D98A31B325	37.2	3.0	165.0	180.0	17.0	81.8	0.8	90.0	–	
KFM06A	6	1	1	1	1	62.0	113.52	3.13E–09	339642D98A31BB74	62.1	3.6	4.0	28.0	345.3	2.7	0.6	14.3	–	multiple
KFM06A	7	1	1	1	2	66.0	115.20	6.85E–09	5E9642D98A31C1FD	66.0	3.6	12.0	28.0	351.6	7.9	0.6	12.8	–	
KFM06A	8	1	1	1	1	67.0	116.23	3.90E–08	085642D98A31C608	67.1	3.6	359.0	28.0	32.7	6.9	0.6	12.3	–	
KFM06A	9	1	1	1	1	78.0	116.74	2.53E–07	E5D642D98A31C801	78.4	3.6	17.0	28.0	19.1	19.0	0.6	7.9	–	
KFM06A	10	1	1	1	2	70.0	122.99	1.70E–09	189642D98A31E06A	69.7	3.6	7.3	28.0	14.4	10.1	0.6	11.3	–	
KFM06A	11	1	1	1	5	75.0	125.84	7.31E–06	081642D98A31EB8E	75.4	3.6	3.5	28.0	25.7	15.4	0.5	9.0	–	
KFM06A	12	1	1	1	2	75.0	126.75	4.30E–07	845642D98A31EF1B	74.6	3.6	10.6	28.0	18.1	15.0	0.7	9.4	–	
KFM06A	30	2	2	2	1	71.0	145.76	6.27E–09	E35642D98A32395B	71.3	3.6	34.3	28.0	354.5	17.7	0.6	10.8	–	multiple
KFM06A	31	1	1	1	1	70.0	148.40	3.38E–10	91D642D98A3243B4	69.7	3.6	34.3	28.0	349.6	17.1	0.8	11.4	–	

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KFM06A	32	1	1	3	1	80.0	151.86	3.02E–10	8ED642D98A325132	79.5	3.6	70.4	28.0	9.3	28.1	0.9	7.6	–	
KFM06A	33	1	1	2	1	61.0	153.86	4.44E–09	EF9642D98A325907	60.9	3.6	15.0	28.0	314.5	7.5	0.6	14.9	–	
KFM06A	34	1	1	1	4	78.0	156.63	9.66E–07	209642D98A3263DB	78.1	3.6	196.0	28.0	35.5	41.7	0.8	8.3	–	
KFM06A	35	1	1	1	1	85.0	156.86	6.65E–09	3BD642D98A3264BA	85.3	3.6	353.0	28.0	31.9	25.4	0.7	5.4	–	
KFM06A	36	1	1	1	2	34.0	160.17	1.05E–07	5C9642D98A3271AD	33.5	3.0	54.0	8.6	288.5	43.7	0.9	8.9	–	
KFM06A	37	1	1	2	1	17.0	161.66	2.28E–09	B95642D98A32777E	17.4	1.4	321.0	7.0	160.5	50.9	0.3	7.8	–	
KFM06A	38	1	1	1	1	84.0	162.16	5.19E–09	699642D98A327975	84.0	3.6	41.0	28.0	22.1	25.8	0.8	5.8	–	
KFM06A	39	1	1	1	1	71.0	162.81	1.53E–08	60D642D98A327BFD	71.1	3.6	6.0	29.0	21.4	11.5	0.6	11.0	–	
KFM06A	40	1	1	1	1	80.0	165.22	7.57E–08	7D5642D98A328563	79.9	3.6	93.8	29.0	12.1	32.2	0.8	7.7	–	
KFM06A	41	1	1	1	1	63.0	167.06	6.84E–09	971642D98A328C94	63.2	3.6	343.6	29.0	91.3	8.5	0.5	14.4	–	
KFM06A	42	1	1	1	1	71.0	168.36	1.85E–07	F89642D98A3291A8	71.2	3.6	342.5	29.0	56.0	13.4	0.5	11.1	–	
KFM06A	43	1	1	1	1	34.0	169.76	6.92E–09	3D5642D98A32971E	33.8	3.0	160.4	9.6	15.1	85.0	1.3	9.8	–	
KFM06A	44	1	2	2	0	3.0	172.64	3.98E–09	53D642D98A32A264	3.3	1.4	213.2	8.0	247.7	68.2	1.2	9.1	O/PO/S	
KFM06A	45	1	1	2	1	58.0	173.38	1.46E–09	69D642D98A32A549	57.8	3.0	35.1	9.6	311.0	18.1	1.0	6.8	–	
KFM06A	46	1	1	1	2	86.0	177.04	3.25E–06	78D642D98A32B38C	85.7	3.6	229.8	29.0	38.2	33.2	0.5	5.3	–	
KFM06A	47	1	1	1	1	63.0	180.44	8.54E–08	D95642D98A32C0DB	63.3	3.6	338.6	29.0	93.9	10.8	0.8	14.4	–	
KFM06A	48	1	1	1	2	61.0	180.75	9.43E–06	C89642D98A32C20A	61.4	3.6	336.5	29.0	104.0	11.6	0.8	15.2	–	
KFM06A	75	1	1	1	2	56.0	296.40	2.16E–08	945642D98A3485D4	55.9	3.0	350.0	8.6	146.1	6.0	1.2	6.3	–	multiple
KFM06A	76	1	2	2	0	55.0	302.08	4.85E–10	C3D642D98A349C05	55.1	3.0	352.0	9.6	158.4	5.4	0.4	6.8	O/PO/S	
KFM06A	77	1	1	1	2	55.0	305.22	5.65E–09	FE9642D98A34A848	54.8	3.0	344.0	9.6	140.5	9.5	0.5	7.0	–	
KFM06A	78	1	1	1	3	56.0	307.55	1.51E–08	D75642D98A34B162	56.2	3.0	349.0	9.6	140.5	6.3	0.4	6.7	–	
KFM06A	92	1	1	3	1	36.0	383.74	2.56E–09	719642D98A35DAFB	36.2	3.0	179.0	8.6	35.5	86.5	0.7	8.8	–	
KFM06A	93	1	2	2	0	51.0	391.40	2.38E–08	AD1642D98A35F8ED	51.4	3.0	319.0	8.6	123.1	24.2	0.1	7.1	O/PO/S	
KFM06A	94	1	1	3	1	51.0	447.92	3.31E–10	075642D98A36D5AD	51.1	3.0	338.6	8.6	144.9	13.7	1.4	6.9	–	
KFM07A	23	1	1	1	3	44.0	260.88	9.27E–08	285742D98A23FB11	44.3	3.0	31.0	7.6	243.5	23.6	1.2	6.6	–	
KFM07A	24	1	1	2	1	31.0	912.90	2.00E–07	565742D98A2DEE01	31.4	3.0	139.3	7.6	169.9	88.6	3.8	7.8	–	multiple
KFM07A	25	1	1	2	1	45.0	913.21	2.00E–07	8E9742D98A2DEF3C	44.9	7.4	133.1	72.0	351.7	77.1	3.5	53.5	–	multiple
KFM07C	2	1	1	1	1	64.0	108.14	2.88E–09	5B9742D98811A671	64.2	3.6	17.8	30.0	87.2	19.9	1.1	15.4	–	
KFM07C	3	1	1	2	1	57.0	108.82	1.12E–09	A3D742D98811A917	57.4	3.0	17.2	10.6	85.0	26.6	0.7	8.3	–	
KFM07C	4	1	1	1	1	76.0	111.30	3.85E–08	B7D742D98811B2C8	76.2	3.6	55.9	33.0	146.5	11.5	1.7	10.3	–	
KFM07C	5	1	1	2	1	84.0	114.73	8.99E–10	F25742D98811C02D	84.1	3.6	175.9	33.0	242.1	12.2	0.5	6.4	–	
KFM07C	6	1	1	1	1	78.0	115.83	6.86E–08	499742D98811C475	78.0	3.6	169.9	30.0	237.4	18.2	0.5	9.0	–	

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KFM07C	7	1	1	1	1	80.0	123.11	6.32E–08	911742D98811E0E1	79.7	3.6	172.7	30.0	239.4	16.6	0.5	8.2	–	
KFM07C	8	1	1	1	2	78.0	134.25	4.57E–08	6D9742D988120C6A	78.0	3.6	184.0	31.0	246.6	18.2	1.3	9.2	–	
KFM07C	9	1	1	1	2	84.0	144.04	1.20E–07	A69742D9881232A6	84.0	3.6	179.4	35.0	243.2	12.2	0.5	6.6	–	
KFM07C	10	1	1	1	1	79.0	150.84	9.26E–09	991742D988124D3B	79.3	3.6	187.0	33.0	248.1	16.9	0.5	8.9	–	
KFM07C	11	1	1	1	2	85.0	156.32	4.68E–05	D01742D9881262A5	85.3	3.6	173.5	37.0	241.4	10.9	0.5	6.1	–	
KFM07C	12	1	1	1	2	84.0	163.65	5.03E–08	31D742D988127F44	83.9	3.6	188.7	30.0	248.3	12.2	0.8	6.2	–	
KFM07C	13	1	1	1	2	78.0	225.56	2.56E–08	275742D98813711A	78.1	3.6	147.8	32.0	221.8	17.4	1.3	9.4	–	
KFM07C	14	1	1	1	1	4.0	278.76	8.78E–09	0C9742D9881440E7	3.5	1.4	330.1	9.0	32.2	81.4	2.6	12.5	–	
KFM08A	1	2	2	1	1	19.0	107.63	2.48E–10	A39842D98A21A46C	19.3	1.4	190.0	6.0	235.8	77.7	1.0	7.0	–	
KFM08A	2	1	1	1	2	61.0	111.17	3.11E–09	7DD842D98A21B23F	61.0	3.6	11.0	27.0	350.3	6.4	0.8	14.4	–	
KFM08A	3	1	1	1	1	62.0	116.79	2.76E–10	DE9842D98A21C839	62.3	3.6	358.0	27.0	58.7	4.5	0.5	13.8	–	
KFM08A	4	1	1	1	1	59.0	119.96	5.53E–10	F4D842D98A21D49C	59.4	3.0	12.0	8.6	336.5	6.4	1.7	6.1	–	
KFM08A	5	1	1	1	2	50.0	130.14	2.04E–09	1A1842D98A21FC60	49.7	3.0	357.1	7.6	213.8	8.1	1.5	6.5	–	
KFM08A	6	1	1	3	1	61.0	131.55	8.42E–09	2AD842D98A2201E2	61.4	3.6	7.0	27.0	7.2	5.2	0.8	14.2	–	
KFM08A	7	1	1	1	2	58.0	134.86	3.99E–09	DD5842D98A220ECB	58.0	3.0	356.0	7.6	125.0	2.2	1.2	5.7	–	
KFM08A	8	1	1	1	1	59.0	144.70	2.33E–09	221842D98A22353D	59.0	3.0	341.0	7.6	120.6	10.1	0.8	5.8	–	
KFM08A	9	1	1	2	1	54.0	152.60	1.04E–09	061842D98A22541C	54.1	3.0	334.0	7.6	139.3	14.9	1.1	6.3	–	
KFM08A	10	1	1	3	1	47.0	173.44	3.65E–10	705842D98A22A57B	47.2	3.0	355.0	7.6	208.9	10.2	1.3	6.7	–	multiple
KFM08A	11	1	1	1	1	75.0	174.14	5.89E–10	F1D842D98A22A83D	74.5	3.6	76.0	27.0	19.9	32.6	1.4	9.7	–	
KFM08A	12	1	1	1	1	47.0	184.88	1.32E–07	53D842D98A22D232	47.0	3.0	349.0	7.6	189.7	11.9	1.2	6.8	–	
KFM08A	13	1	1	3	1	39.0	185.16	2.12E–08	C09842D98A22D348	39.3	3.0	142.9	7.6	20.5	78.9	1.2	8.0	–	
KFM08A	14	1	1	1	2	48.0	187.12	4.81E–09	C91842D98A22DAED	48.0	3.0	347.2	7.6	182.2	11.7	0.7	6.7	–	
KFM08A	15	1	1	1	2	49.0	189.39	2.20E–06	3F5842D98A22E3D2	48.9	3.0	0.2	7.6	230.1	7.9	1.5	6.5	–	
KFM08A	16	1	1	1	2	56.0	190.01	1.18E–06	43D842D98A22E63D	55.6	3.0	351.0	7.6	148.8	5.1	1.4	6.0	–	
KFM08A	17	1	1	1	2	49.0	193.19	2.34E–07	B5D842D98A22F2A3	48.5	3.0	351.0	7.6	192.1	9.9	1.1	6.6	–	
KFM08A	18	1	1	1	1	49.0	196.01	1.83E–09	A01842D98A22FDAE	49.0	3.0	2.0	7.6	238.8	7.8	1.6	6.5	–	
KFM08A	19	1	1	1	1	46.0	196.84	4.27E–08	33D842D98A2300E9	45.5	3.0	354.0	7.6	208.1	11.8	1.3	6.9	–	
KFM08A	20	1	1	1	4	45.0	197.43	2.42E–07	F45842D98A230332	45.0	3.0	351.0	7.6	199.6	13.0	1.2	7.0	–	multiple
KFM08A	21	1	1	1	1	46.0	199.27	1.89E–09	A51842D98A230A64	46.3	3.0	348.0	7.6	188.6	12.8	1.9	6.9	–	
KFM08A	22	1	1	1	1	46.0	201.53	2.87E–09	CB9842D98A231337	45.8	3.0	348.6	7.6	191.3	13.0	1.0	6.9	–	multiple
KFM08A	23	1	1	1	1	55.0	210.14	3.90E–10	835842D98A2334DA	54.9	3.0	21.9	7.6	321.9	12.4	1.1	6.2	–	
KFM08A	24	1	1	1	1	37.0	241.27	2.75E–10	655842D98A23AE78	36.5	3.0	160.5	7.6	34.0	86.3	0.7	8.2	–	multiple

Idcode	PFL-NO	B/U	O/PO/S	C/ Pr/Po	Aperture	Alpha	Secup	T PFL–F	FEATURE_ID	ALPHA	UNCERT_ ALPHA	BETA	UNCERT_ BETA	STRIKE	DIP	Orientation change	Max uncertainty	Difference between data sets	Multiple possible fractures
KFM08A	31	1	1	2	1	42.0	408.73	3.57E–10	971842D98A263C9D	42.4	3.0	131.0	10.6	18.3	76.0	1.6	9.8	–	
KFM08A	32	1	1	2	1	42.0	409.96	4.46E–09	019842D98A264164	41.7	3.0	130.0	10.6	17.1	76.4	1.2	9.8	–	
KFM08A	33	1	1	2	1	58.0	410.46	3.08E–09	1A5842D98A264359	57.7	3.0	108.0	7.6	15.0	55.2	0.8	6.4	–	
KFM08A	34	1	1	1	1	49.0	411.90	3.77E–09	C4D842D98A2648FD	49.0	3.0	8.0	7.6	291.7	6.1	1.0	6.5	–	multiple
KFM08A	35	1	1	2	1	62.0	430.55	3.03E–10	005842D98A2691DA	61.7	3.6	9.0	27.0	29.9	10.6	1.4	14.2	–	
KFM08A	36	1	1	1	1	50.0	450.65	5.54E–10	10D842D98A26E05F	50.2	3.0	348.7	7.6	153.2	7.3	1.8	6.5	–	multiple
KFM08A	37	1	1	1	2	45.0	451.49	1.75E–09	C39842D98A26E3A1	44.7	3.0	355.4	7.6	209.4	7.8	2.2	6.9	–	
KFM08A	38	1	3	2	0	65.0	458.60	4.15E–10	D19842D98A26FF6A	64.6	3.6	19.0	27.0	24.8	16.2	1.9	13.2	–	
KFM08C	1	1	2	2	0	49.0	102.29	2.95E–06	695842D988218F94	48.5	3.0	229.0	180.0	158.4	64.5	1.6	86.3	O/PO/S	
KFM08C	2	1	1	1	1	18.0	161.30	2.77E–09	661842D988227610	17.9	1.4	106.0	8.0	61.1	82.9	4.1	8.5	–	
KFM08C	5	1	1	1	1	58.0	219.24	3.02E–09	CAD842D988235868	57.9	3.0	17.0	9.6	50.7	9.1	5.4	6.2	–	
KFM08C	6	1	1	2	1	55.0	225.06	7.72E–10	9F5842D988236F27	55.0	3.0	17.0	9.6	33.3	9.7	5.7	6.6	–	multiple
KFM08C	7	1	1	1	1	56.0	282.95	4.97E–09	1D9842D988245145	55.9	3.0	20.0	9.6	45.7	11.1	5.6	6.5	–	
KFM10A	35	2	3	1	0	11.0	255.15	2.61E–09	161046D98A13E4B1	10.7	7.4	110.0	74.0	217.9	83.5	3.0	74.2	–	
KFM10A	36	1	1	1	2	32.0	299.66	3.57E–08	961046D98A14928D	32.3	3.0	342.7	9.6	228.0	16.9	0.2	9.1	–	
KFM10A	37	1	1	1	1	31.0	309.03	8.82E–09	B29046D98A14B726	30.6	3.0	344.0	9.6	234.1	17.1	0.4	9.3	–	
KFM10A	38	1	1	1	2	34.0	315.51	2.04E–07	BA5046D98A14D078	34.3	3.0	348.7	9.6	234.0	11.4	0.2	8.9	–	
KFM10A	39	1	1	1	1	25.0	322.13	9.50E–09	CA5046D98A14EA52	24.7	1.4	347.3	8.0	252.6	19.6	0.3	7.8	–	
KFM10A	40	1	1	1	3	68.0	327.42	1.15E–07	21D046D98A14FEFE	68.0	3.6	318.0	29.0	135.2	35.1	0.4	12.6	–	multiple
KFM10A	41	1	1	1	1	57.0	328.24	1.96E–08	F11046D98A15022F	56.9	3.0	327.0	9.6	151.2	26.5	0.3	6.6	–	
KFM10A	42	1	1	1	1	48.0	328.88	2.25E–08	2ED046D98A1504B4	47.9	3.0	337.0	9.6	168.7	17.7	0.3	7.6	–	
KFM10A	43	1	1	1	1	37.0	332.98	3.42E–09	F21046D98A1514B5	37.2	3.0	344.7	9.6	212.0	12.4	0.4	8.6	–	
KFM10A	44	1	1	1	3	44.0	334.57	5.63E–08	BAD046D98A151AEC	44.0	3.0	346.0	9.6	178.0	10.8	0.4	7.9	–	multiple
KFM10A	45	1	1	3	1	55.0	360.31	4.74E–09	1DD046D98A157F77	54.8	7.4	235.3	74.0	140.1	74.3	0.4	45.6	–	
KFM10A	46	1	1	2	1	49.0	368.32	3.27E–09	D49046D98A159EBF	49.3	3.0	311.3	9.6	169.2	35.4	1.0	7.6	–	
KFM10A	47	1	1	1	2	44.0	373.55	1.04E–08	25D046D98A15B32C	43.9	3.0	342.7	9.6	176.1	13.7	0.5	7.9	–	
KFM10A	48	1	1	1	2	49.0	375.93	2.46E–09	C99046D98A15BC79	49.2	3.0	346.7	9.6	150.2	13.7	0.3	7.4	–	

Appendix 2

VBA macro used in the work

```
Option Explicit


Sub main()

Dim holeName As String
Dim featId As String
Dim currentWorkbook As String



Dim i As Long
Dim j As Integer

Dim nofHeadRow As Integer
Dim IdCol As Integer
Dim SecUpCol As Integer
Dim AdjSecUpCol As Integer
Dim FracMapCol As Integer
Dim FracIntpretCol As Integer
Dim ConfCol As Integer
Dim ApertureCol As Integer
Dim AlphaCol As Integer
Dim alphaUncCol As Integer
Dim betaCol As Integer
Dim BetaUncCol As Integer
Dim StrikeCol As Integer
Dim DipCol As Integer
Dim featIdCol As Integer

Dim adjSecUp As Single

Dim bearing As Single
Dim bearUncert As Single
Dim inclination As Single
Dim inclUncert As Single

Dim alpha As Single
Dim alphaUncert As Single
Dim beta As Single
Dim betaUncert As Single

Dim oldStrike As Single
Dim oldDip As Single
Dim dihedralAngle As Single

Dim orientData(1 To 200, 1 To 4) As Single
Dim featIdVect(1 To 200) As String

Sheets("All PFL").Select
Range("A1").Select

currentWorkbook = ActiveWorkbook.Name

'*******************************************************
'*** Find corresponding fracture and print new data ***
'*******************************************************
```

```
Call find_columns_in_p_fract_core(IdCol, SecUpCol, AdjSecUpCol,
FracMapCol, FracIntpretCol, ConfCol, ApertureCol, AlphaCol,
alphaUncCol, betaCol, BetaUncCol, StrikeCol, DipCol, featIdCol,
nofHeadRow)

Sheets("All PFL").Select
Range("A1").Select

Call print_headers

i = 1
While ActiveCell.Offset(i, 0) <> ""

   If ActiveCell.Offset(i, 18) = 1 Then
      Call compare_fractures(IdCol, SecUpCol, AdjSecUpCol, FracMapCol,
FracIntpretCol, ConfCol, ApertureCol, AlphaCol, alphaUncCol, betaCol,
BetaUncCol, StrikeCol, DipCol, featIdCol, i, nofHeadRow)
   End If

   Sheets("All PFL").Select

   i = i + 1
Wend


'*******************************************************
'***                Make move plots                  ***
'*******************************************************
i = 1
holeName = ActiveCell.Offset(0, 0)

    Workbooks.Open Filename:= _
        "move_plots.xls"

Windows(currentWorkbook).Activate
Sheets("All PFL").Select
Range("A1").Select

While ActiveCell.Offset(i, 0) <> ""
   If holeName <> ActiveCell.Offset(i, 0) Then
      holeName = ActiveCell.Offset(i, 0)
      Call create_new_move_sheet(holeName)

      Windows(currentWorkbook).Activate
      Sheets("All PFL").Select
      Range("A1").Select

   Else
      j = 0
      While ActiveCell.Offset(i, 0) = holeName
         If ActiveCell.Offset(i, 18) = 1 Then
            j = j + 1
            orientData(j, 1) = ActiveCell.Offset(i, 8)
            orientData(j, 2) = ActiveCell.Offset(i, 9)
            orientData(j, 3) = ActiveCell.Offset(i, 27)
            orientData(j, 4) = ActiveCell.Offset(i, 28)
            featIdVect(j) = ActiveCell.Offset(i, 20)
         End If
         i = i + 1
      Wend

      Windows("move_plots.xls").Activate
      Sheets(holeName & "_move").Select
      Range("A1").Select

      Call print_movedata(orientData, featIdVect, j, holeName)
```

```
      Windows(currentWorkbook).Activate '
      Sheets("All PFL").Select
      Range("A1").Select

   End If
Wend


'*******************************************************
'***            Make uncertainty plots              ***
'*******************************************************


Windows(currentWorkbook).Activate

Sheets("All PFL").Select
Range("A1").Select

i = 1
holeName = ActiveCell.Offset(0, 0)

While ActiveCell.Offset(i, 0) <> ""

   If holeName <> ActiveCell.Offset(i, 0) Then
      If i <> 1 Then
         Call SortUncertdata(holeName)
         Call CloseUncertWorkbook(holeName)
      End If
      holeName = ActiveCell.Offset(i, 0)
      Call MakeUncertWorkbook(holeName)
   End If

   Windows(currentWorkbook).Activate
   Sheets("All PFL").Select
   Range("A1").Select

   If ActiveCell.Offset(i, 18) = 1 Then
      featId = ActiveCell.Offset(i, 20)
      adjSecUp = ActiveCell.Offset(i, 30)
      oldStrike = ActiveCell.Offset(i, 8)
      oldDip = ActiveCell.Offset(i, 9)
      alpha = ActiveCell.Offset(i, 23)
      alphaUncert = ActiveCell.Offset(i, 24)
      beta = ActiveCell.Offset(i, 25)
      betaUncert = ActiveCell.Offset(i, 26)

      Call find_bh_data(holeName, adjSecUp, bearing, bearUncert,
inclination, inclUncert)
      Call create_new_uncert_sheet(holeName, featId)
      Call print_Uncertaintydata(holeName, featId, alpha, alphaUncert,
beta, betaUncert, bearing, bearUncert, inclination, inclUncert,
oldStrike, oldDip, dihedralAngle)

      Windows(currentWorkbook).Activate
      Sheets("All PFL").Select
      Range("A1").Select

      ActiveCell.Offset(i, 31) = dihedralAngle

   End If
   i = i + 1
Wend
Call CloseUncertWorkbook(holeName)

End Sub
```

```
Sub find_columns_in_p_fract_core(IdCol, SecUpCol, AdjSecUpCol,
FracMapCol, FracIntpretCol, ConfCol, ApertureCol, AlphaCol,
alphaUncCol, betaCol, BetaUncCol, StrikeCol, DipCol, featIdCol,
nofHeadRow)

Dim i As Integer
Dim j As Integer


Sheets("p_fract_core").Select
Range("A1").Select

i = 0
While Trim(ActiveCell.Offset(i, 0)) = ""
   i = i + 1
Wend
nofHeadRow = i

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "IDCODE"
   j = j + 1
Wend
IdCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "SECUP"
   j = j + 1
Wend
SecUpCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "ADJUSTEDSECUP"
   j = j + 1
Wend
AdjSecUpCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "FRACT_MAPPED"
   j = j + 1
Wend
FracMapCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "FRACT_INTERPRET"
   j = j + 1
Wend
FracIntpretCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "CONFIDENCE_CODE"
   j = j + 1
Wend
ConfCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "APERTURE"
   j = j + 1
Wend
ApertureCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "ALPHA"
   j = j + 1
Wend
```

```
AlphaCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "UNCERT_ALPHA"
   j = j + 1
Wend
alphaUncCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "BETA"
   j = j + 1
Wend
betaCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "UNCERT_BETA"
   j = j + 1
Wend
BetaUncCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "STRIKE"
   j = j + 1
Wend
StrikeCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "DIP"
   j = j + 1
Wend
DipCol = j

j = 0
While ActiveCell.Offset(nofHeadRow, j) <> "FEATURE_ID"
   j = j + 1
Wend
featIdCol = j

End Sub

Sub print_headers()


      ActiveCell.Offset(0, 23) = "alpha"
      ActiveCell.Offset(0, 24) = "alphaUncert"
      ActiveCell.Offset(0, 25) = "beta"
      ActiveCell.Offset(0, 26) = "betaUncert"
      ActiveCell.Offset(0, 27) = "strike"
      ActiveCell.Offset(0, 28) = "dip"
      ActiveCell.Offset(0, 29) = "dihidralAngle"
      ActiveCell.Offset(0, 30) = "adjusted secup"
      ActiveCell.Offset(0, 31) = "maximum uncertainty dihedral angle"

End Sub
Sub compare_fractures(IdCol, SecUpCol, AdjSecUpCol, FracMapCol,
FracIntpretCol, ConfCol, ApertureCol, AlphaCol, alphaUncCol, betaCol,
BetaUncCol, StrikeCol, DipCol, featIdCol, PFLrow, nofHeadRow)

Dim pflHoleName As String
Dim pflSecup As Single
Dim pflFracMap As Integer 'broken/unbroken 1/2
Dim pflFracInterpret As Integer 'open/partly open/sealed 1/2/3
Dim pflConf As Integer 'Certain/probable/POssible 1/2/3
Dim pflAperture As Single
Dim pflAlpha As Single
```

```
Dim i As Long
Dim j As Long

Dim test1 As Long
Dim test2 As Long

Dim nofEqual As Integer
Dim points As Integer
Dim maxPoints As Integer
Dim rowNumb As Integer

Dim pointsVect(1 To 10) As Integer

Dim diffcause As String

Dim dummy As Single

Dim featId As String
Dim alpha As Single
Dim alphaUncert As Single
Dim beta As Single
Dim betaUncert As Single
Dim strike As Single
Dim dip As Single
Dim adjSecUp As Single


pflHoleName = ActiveCell.Offset(PFLrow, 0)
pflFracMap = ActiveCell.Offset(PFLrow, 2)
pflFracInterpret = ActiveCell.Offset(PFLrow, 3)
pflConf = ActiveCell.Offset(PFLrow, 4)
pflAperture = ActiveCell.Offset(PFLrow, 5)
pflAlpha = ActiveCell.Offset(PFLrow, 6)
pflSecup = ActiveCell.Offset(PFLrow, 7)

Sheets("p_fract_core").Select
Range("A1").Select

i = nofHeadRow

While ActiveCell.Offset(i, IdCol) <> pflHoleName
   i = i + 1
Wend

nofEqual = 0
While Round(ActiveCell.Offset(i, SecUpCol) + 0.0001, 2) < pflSecup
'''''   If Int(100 * Round(ActiveCell.Offset(i, adjSecUpCol), 2)) =
Int(100 * Round(pflSecup, 2)) Then nofEqual = nofEqual + 1
   i = i + 1
Wend


test1 = Round(100 * Round(ActiveCell.Offset(i, SecUpCol), 2), 0)
test2 = Round(100 * pflSecup, 0)

While Abs(test1 - test2) <= 1
  nofEqual = nofEqual + 1
  i = i + 1
  test1 = Round(100 * Round(ActiveCell.Offset(i, SecUpCol), 2), 0)
Wend

points = 0
If nofEqual = 1 Then

   featId = ActiveCell.Offset(i - 1, featIdCol)
```

```
   If ActiveCell.Offset(i - 1, FracMapCol) = "Broken" And pflFracMap =
1 Then
      points = points + 1
   ElseIf ActiveCell.Offset(i - 1, FracMapCol) = "Unbroken" And
pflFracMap = 2 Then
      points = points + 1
   Else
      diffcause = "Diff in B/U"
   End If

   If ActiveCell.Offset(i - 1, FracIntpretCol) = "Open" And
pflFracInterpret = 1 Then
      points = points + 1
   ElseIf ActiveCell.Offset(i - 1, FracIntpretCol) = "Partly open" And
pflFracInterpret = 2 Then
      points = points + 1
   ElseIf ActiveCell.Offset(i - 1, FracIntpretCol) = "Sealed" And
pflFracInterpret = 3 Then
      points = points + 1
   Else
      diffcause = "Diff in O/PO/S"
   End If

   If ActiveCell.Offset(i - 1, ConfCol) = pflConf Then
      points = points + 1
   Else
      diffcause = "Diff in confidence"
   End If

   If ActiveCell.Offset(i - 1, ApertureCol) = pflAperture Then
      points = points + 1
   Else
      diffcause = "Diff in aperture"
   End If

   If ActiveCell.Offset(i - 1, AlphaCol) = pflAlpha Then
      points = points + 1
   Else
      diffcause = "Diff in alpha"
   End If


   If points >= 4 Then

      alpha = ActiveCell.Offset(i - 1, AlphaCol)
      alphaUncert = ActiveCell.Offset(i - 1, alphaUncCol)

      beta = ActiveCell.Offset(i - 1, betaCol)
      betaUncert = ActiveCell.Offset(i - 1, BetaUncCol)

      strike = ActiveCell.Offset(i - 1, StrikeCol)
      dip = ActiveCell.Offset(i - 1, DipCol)

      adjSecUp = ActiveCell.Offset(i - 1, AdjSecUpCol)

      Sheets("All PFL").Select
      Range("A1").Select
      ActiveCell.Offset(PFLrow, 20) = featId
      ActiveCell.Offset(PFLrow, 21) = diffcause

      ActiveCell.Offset(PFLrow, 23) = alpha
      ActiveCell.Offset(PFLrow, 24) = alphaUncert
      ActiveCell.Offset(PFLrow, 25) = beta
      ActiveCell.Offset(PFLrow, 26) = betaUncert

      ActiveCell.Offset(PFLrow, 27) = strike
```

```
      ActiveCell.Offset(PFLrow, 28) = dip

      ActiveCell.Offset(PFLrow, 29) =
calculate_dihedral_from_strike_dip(strike, dip,
ActiveCell.Offset(PFLrow, 8), ActiveCell.Offset(PFLrow, 9))

      ActiveCell.Offset(PFLrow, 30) = adjSecUp

   Else
      Sheets("All PFL").Select
      Range("A1").Select
      ActiveCell.Offset(PFLrow, 21) = "only " & points & " equal"
   End If


Else
   For j = 1 To nofEqual

      points = 0
      If ActiveCell.Offset(i - j, FracMapCol) = "Broken" And
pflFracMap = 1 Then
         points = points + 1
      ElseIf ActiveCell.Offset(i - j, FracMapCol) = "Unbroken" And
pflFracMap = 2 Then
         points = points + 1
      End If

      If ActiveCell.Offset(i - j, FracIntpretCol) = "Open" And
pflFracInterpret = 1 Then
         points = points + 1
      ElseIf ActiveCell.Offset(i - j, FracIntpretCol) = "Partly open"
And pflFracInterpret = 2 Then
         points = points + 1
      ElseIf ActiveCell.Offset(i - j, FracIntpretCol) = "Sealed" And
pflFracInterpret = 3 Then
         points = points + 1
      End If

      If ActiveCell.Offset(i - j, ConfCol) = pflConf Then
         points = points + 1
      End If

      If ActiveCell.Offset(i - j, ApertureCol) = pflAperture Then
         points = points + 1
      End If

      If ActiveCell.Offset(i - j, AlphaCol) = pflAlpha Then
         points = points + 1
      End If

      pointsVect(j) = points
   Next

   maxPoints = 0
   For j = 1 To nofEqual
      If pointsVect(j) > maxPoints Then
         maxPoints = pointsVect(j)
         rowNumb = j
      End If
   Next



   featId = ActiveCell.Offset(i - rowNumb, featIdCol)
```

```
   If ActiveCell.Offset(i - rowNumb, FracMapCol) = "Broken" And
pflFracMap = 1 Then
      points = points + 1
   ElseIf ActiveCell.Offset(i - rowNumb, FracMapCol) = "Unbroken" And
pflFracMap = 2 Then
      points = points + 1
   Else
      diffcause = "Diff in B/U"
   End If

   If ActiveCell.Offset(i - rowNumb, FracIntpretCol) = "Open" And
pflFracInterpret = 1 Then
      points = points + 1
   ElseIf ActiveCell.Offset(i - rowNumb, FracIntpretCol) = "Partly
open" And pflFracInterpret = 2 Then
      points = points + 1
   ElseIf ActiveCell.Offset(i - rowNumb, FracIntpretCol) = "Sealed"
And pflFracInterpret = 3 Then
      points = points + 1
   Else
      diffcause = "Diff in O/PO/S"
   End If

   If ActiveCell.Offset(i - rowNumb, ConfCol) = pflConf Then
      points = points + 1
   Else
      diffcause = "Diff in confidence"
   End If

   If ActiveCell.Offset(i - rowNumb, ApertureCol) = pflAperture Then
      points = points + 1
   Else
      diffcause = "Diff in aperture"
   End If

   If ActiveCell.Offset(i - rowNumb, AlphaCol) = pflAlpha Then
      points = points + 1
   Else
      diffcause = "Diff in alpha"
   End If


   If points >= 4 Then
      alpha = ActiveCell.Offset(i - rowNumb, AlphaCol)
      alphaUncert = ActiveCell.Offset(i - rowNumb, alphaUncCol)

      beta = ActiveCell.Offset(i - rowNumb, betaCol)
      betaUncert = ActiveCell.Offset(i - rowNumb, BetaUncCol)

      strike = ActiveCell.Offset(i - rowNumb, StrikeCol)
      dip = ActiveCell.Offset(i - rowNumb, DipCol)

      adjSecUp = ActiveCell.Offset(i - rowNumb, AdjSecUpCol)

      Sheets("All PFL").Select
      Range("A1").Select
      ActiveCell.Offset(PFLrow, 20) = featId
      ActiveCell.Offset(PFLrow, 21) = diffcause

      ActiveCell.Offset(PFLrow, 23) = alpha
      ActiveCell.Offset(PFLrow, 24) = alphaUncert
      ActiveCell.Offset(PFLrow, 25) = beta
      ActiveCell.Offset(PFLrow, 26) = betaUncert

      ActiveCell.Offset(PFLrow, 27) = strike
      ActiveCell.Offset(PFLrow, 28) = dip
```

```
      ActiveCell.Offset(PFLrow, 29) =
calculate_dihedral_from_strike_dip(strike, dip,
ActiveCell.Offset(PFLrow, 8), ActiveCell.Offset(PFLrow, 9))

      ActiveCell.Offset(PFLrow, 30) = adjSecUp

   Else
      Sheets("All PFL").Select
      Range("A1").Select
      ActiveCell.Offset(PFLrow, 21) = "only " & points & " equal"
   End If

      ActiveCell.Offset(PFLrow, 22) = "multiple"


End If

ErrorTrap:

End Sub

Function calculate_dihedral_from_strike_dip(strike1, dip1, strike2,
dip2)

Dim alfa1 As Double
Dim beta1 As Double
Dim gamma1 As Double
Dim alfa2 As Double
Dim beta2 As Double
Dim gamma2 As Double
Dim Pi As Double
Dim x As Double

Pi = 4 * Atn(1)

alfa1 = Cos(-strike1 * Pi / 180) * Sin(dip1 * Pi / 180)
beta1 = Sin(-strike1 * Pi / 180) * Sin(dip1 * Pi / 180)
gamma1 = Cos(dip1 * Pi / 180)

alfa2 = Cos(-strike2 * Pi / 180) * Sin(dip2 * Pi / 180)
beta2 = Sin(-strike2 * Pi / 180) * Sin(dip2 * Pi / 180)
gamma2 = Cos(dip2 * Pi / 180)

x = Abs(alfa1 * alfa2 + beta1 * beta2 + gamma1 * gamma2)

If x < 1 Then
   calculate_dihedral_from_strike_dip = (Atn(-x / Sqr(-x * x + 1)) + 2
* Atn(1)) * 180 / Pi
Else
   calculate_dihedral_from_strike_dip = 0
End If

End Function

Sub create_new_move_sheet(holeName)

Windows("move_plots.xls").Activate

Sheets("Template_move").Select
Sheets("Template_move").Copy Before:=Sheets("Template_move")
Sheets("Template_move (2)").Select
Sheets("Template_move (2)").Name = holeName & "_move"
Range("A1").Select
```

```
End Sub

Sub print_movedata(orientData, featIdVect, nofData, holeName)

Dim i As Integer
Dim Pi As Double

Pi = 4 * Atn(1)

ActiveCell.Offset(0, 0) = holeName


For i = 1 To nofData

   ActiveCell.Offset(i + 2, 0) = featIdVect(i)
   ActiveCell.Offset(i + 2, 1) = orientData(i, 1)
   ActiveCell.Offset(i + 2, 2) = orientData(i, 2)
   ActiveCell.Offset(i + 2, 3) = orientData(i, 3)
   ActiveCell.Offset(i + 2, 4) = orientData(i, 4)

   'old definition
'   ActiveCell.Offset(i + 2, 5) = Cos((180 - orientData(i, 1)) * Pi /
180) * orientData(i, 2) / 90
'   ActiveCell.Offset(i + 2, 6) = Sin((180 - orientData(i, 1)) * Pi /
180) * orientData(i, 2) / 90
'   ActiveCell.Offset(i + 2, 7) = Cos((180 - orientData(i, 3)) * Pi /
180) * orientData(i, 4) / 90
'   ActiveCell.Offset(i + 2, 8) = Sin((180 - orientData(i, 3)) * Pi /
180) * orientData(i, 4) / 90

   'Equal Area
   ActiveCell.Offset(i + 2, 5) = Cos((180 - orientData(i, 1)) * Pi /
180) * Sin((orientData(i, 2)) / 2 * Pi / 180) * 2 ^ 0.5
   ActiveCell.Offset(i + 2, 6) = Sin((180 - orientData(i, 1)) * Pi /
180) * Sin((orientData(i, 2)) / 2 * Pi / 180) * 2 ^ 0.5

   ActiveCell.Offset(i + 2, 7) = Cos((180 - orientData(i, 3)) * Pi /
180) * Sin((orientData(i, 4)) / 2 * Pi / 180) * 2 ^ 0.5
   ActiveCell.Offset(i + 2, 8) = Sin((180 - orientData(i, 3)) * Pi /
180) * Sin((orientData(i, 4)) / 2 * Pi / 180) * 2 ^ 0.5

   ActiveCell.Offset(i * 3, 9) = ActiveCell.Offset(i + 2, 5)
   ActiveCell.Offset(i * 3, 10) = ActiveCell.Offset(i + 2, 6)
   ActiveCell.Offset(i * 3 + 1, 9) = ActiveCell.Offset(i + 2, 7)
   ActiveCell.Offset(i * 3 + 1, 10) = ActiveCell.Offset(i + 2, 8)

   ActiveCell.Offset(i - 1, 11) =
calculate_dihedral_from_strike_dip(orientData(i, 1), orientData(i, 2),
orientData(i, 3), orientData(i, 4))
   ActiveCell.Offset(i - 1, 12) = 1 - ((i - 1) / (nofData - 1))
Next

Columns("L:L").Select
Selection.Sort Key1:=Range("L1"), Order1:=xlDescending,
Header:=xlGuess, _
   OrderCustom:=1, MatchCase:=False, Orientation:=xlTopToBottom, _
   DataOption1:=xlSortNormal


End Sub

Sub find_bh_data(holeName, adjSecUp, bearing, bearUncert, inclination,
inclUncert)

Dim i As Long
```

```
Sheets("object_location").Select
Range("A1").Select

i = 1
While ActiveCell.Offset(i, 0) <> holeName
   i = i + 1
Wend

While adjSecUp > ActiveCell.Offset(i, 7)
   i = i + 1
Wend

If Abs(ActiveCell.Offset(i, 15) - ActiveCell.Offset(i - 1, 15)) > 180
Then
   bearing = (ActiveCell.Offset(i, 15) + ActiveCell.Offset(i - 1, 15)
+ 360) / 2
   If bearing > 360 Then bearing = bearing - 360
Else
   bearing = (ActiveCell.Offset(i, 15) + ActiveCell.Offset(i - 1, 15))
/ 2
End If

inclination = (ActiveCell.Offset(i, 14) + ActiveCell.Offset(i - 1,
14)) / 2
bearUncert = ActiveCell.Offset(i, 17)
inclUncert = ActiveCell.Offset(i, 16)


End Sub

Sub create_new_uncert_sheet(holeName, featId)

Windows(holeName & "_uncert_plots.xls").Activate
Sheets("Template_uncert").Select
Sheets("Template_uncert").Copy Before:=Sheets("Template_uncert")
Sheets("Template_uncert (2)").Select
Sheets("Template_uncert (2)").Name = holeName & "_" & featId & "_unc"
Range("A1").Select


End Sub

Sub print_Uncertaintydata(holeName, featId, alpha, alphaUncert, beta,
betaUncert, bearing, bearUncert, inclination, inclUncert, oldStrike,
oldDip, maxDihedral)

Dim i As Integer
Dim j As Integer
Dim k As Integer
Dim m As Integer
Dim n As Integer

Dim tempBearing As Single
Dim tempInclination As Single
Dim tempAlpha As Single
Dim tempBeta As Single

Dim nofAlphaUncert As Integer
Dim nofBetaUncert As Integer
Dim nofBearUncert As Integer
Dim nofInclUncert As Integer

Dim strike As Single
Dim dip As Single

Dim meanStrike As Single
```

```
Dim meanDip As Single
Dim tempDihedral As Single

Dim Pi As Single

Pi = Atn(1) * 4


ActiveCell.Offset(0, 0) = holeName
ActiveCell.Offset(0, 1) = featId

ActiveCell.Offset(2, 2) = alpha
ActiveCell.Offset(3, 2) = alphaUncert

ActiveCell.Offset(2, 3) = beta
ActiveCell.Offset(3, 3) = betaUncert

ActiveCell.Offset(2, 4) = bearing
ActiveCell.Offset(3, 4) = bearUncert

ActiveCell.Offset(2, 5) = inclination
ActiveCell.Offset(3, 5) = inclUncert

ActiveCell.Offset(3, 8) = oldStrike
ActiveCell.Offset(3, 9) = oldDip

Call calc_strike_dip(alpha, beta, bearing, inclination, meanStrike,
meanDip)


nofAlphaUncert = Int(alphaUncert / 1) + 1
nofBetaUncert = Int(betaUncert / 2.5) + 1
nofBearUncert = Int(bearUncert / 1) + 1
nofInclUncert = Int(inclUncert * 3) + 1
If nofAlphaUncert < 2 Then nofAlphaUncert = 2
If nofBetaUncert < 2 Then nofBetaUncert = 2
If nofBearUncert < 2 Then nofBearUncert = 2
If nofInclUncert < 2 Then nofInclUncert = 2

If nofAlphaUncert > 4 Then nofAlphaUncert = 4
If nofBetaUncert > 35 Then nofBetaUncert = 35
If nofBearUncert > 3 Then nofBearUncert = 3
If nofInclUncert > 3 Then nofInclUncert = 3

maxDihedral = 0
n = 6
ActiveCell.Offset(5, 3) = (nofAlphaUncert + 1) * (nofBetaUncert + 1) *
(nofBearUncert + 1) * (nofInclUncert + 1)
For i = 0 To nofBearUncert
   For j = 0 To nofInclUncert
      For k = 0 To nofAlphaUncert
         For m = 0 To nofBetaUncert

            tempBearing = bearing - bearUncert + (i / nofBearUncert *
2) * bearUncert
            tempInclination = inclination - inclUncert + (j /
nofInclUncert * 2) * inclUncert
            tempAlpha = alpha - alphaUncert + (k / nofAlphaUncert * 2)
* alphaUncert
            tempBeta = beta - betaUncert + (m / nofBetaUncert * 2) *
betaUncert


            Call calc_strike_dip(tempAlpha, tempBeta, tempBearing,
tempInclination, strike, dip)
```

```
'            ActiveCell.Offset(n, 1) = strike
'            ActiveCell.Offset(n, 2) = dip

'            ActiveCell.Offset(n, 3) = Cos((180 - strike) * Pi / 180)
* (dip / 90)
'            ActiveCell.Offset(n, 4) = Sin((180 - strike) * Pi / 180)
* (dip / 90)

            'Equal Area
            ActiveCell.Offset(n, 3) = Cos((180 - strike) * Pi / 180) *
Sin(dip / 2 * Pi / 180) * 2 ^ 0.5
            ActiveCell.Offset(n, 4) = Sin((180 - strike) * Pi / 180) *
Sin(dip / 2 * Pi / 180) * 2 ^ 0.5

            tempDihedral =
calculate_dihedral_from_strike_dip(meanStrike, meanDip, strike, dip)
            If tempDihedral > maxDihedral Then maxDihedral =
tempDihedral

            n = n + 1
         Next
      Next
   Next
Next

Sheets("max_uncert").Select
Range("A1").Select

i = 0
While ActiveCell.Offset(i, 0) <> ""
i = i + 1
Wend

ActiveCell.Offset(i, 0) = featId
ActiveCell.Offset(i, 1) = maxDihedral

End Sub

Sub calc_strike_dip(alpha180, beta180, bear180, incl180, strike180,
dip180)

Dim Pi As Double
Dim pi_over180 As Double
Dim alpha As Double
Dim beta As Double
Dim bear As Double
Dim incl As Double
Dim strike As Double
Dim dip As Double

Dim nx As Double
Dim ny As Double
Dim nz As Double
Dim xynx As Double
Dim xyny As Double

Dim cosAngle As Double
Dim sinAngle As Double

Pi = 4 * Atn(1)
pi_over180 = Atn(1) / 45

alpha = alpha180 * pi_over180
beta = beta180 * pi_over180
bear = bear180 * pi_over180
incl = incl180 * pi_over180
```

```
nx = Cos(Pi / 2 - bear) * Sin(-incl) * Cos(-beta) * Cos(alpha) -
Sin(Pi / 2 - bear) * Sin(-beta) * Cos(alpha) - Cos(Pi / 2 - bear) *
Cos(-incl) * Sin(alpha)
ny = Sin(Pi / 2 - bear) * Sin(-incl) * Cos(-beta) * Cos(alpha) +
Cos(Pi / 2 - bear) * Sin(-beta) * Cos(alpha) - Sin(Pi / 2 - bear) *
Cos(-incl) * Sin(alpha)
nz = Cos(-incl) * Cos(-beta) * Cos(alpha) + Sin(-incl) * Sin(alpha)


strike180 = nx ^ 2 + ny ^ 2 + nz ^ 2

If nz > 0 Then
   nz = -nz
   xynx = -nx / (nx ^ 2 + ny ^ 2) ^ 0.5
   xyny = -ny / (nx ^ 2 + ny ^ 2) ^ 0.5
Else
   xynx = nx / (nx ^ 2 + ny ^ 2) ^ 0.5
   xyny = ny / (nx ^ 2 + ny ^ 2) ^ 0.5
End If

'Arcsin(x) = Atn(x / Sqr(-x * x + 1))
'Arccos(x) = Atn(-x / Sqr(-x * x + 1)) + 2 * Atn(1)
dip180 = 90 + Atn(nz / Sqr(-nz * nz + 1)) / pi_over180

cosAngle = (Atn(-xynx / Sqr(-xynx * xynx + 1)) + 2 * Atn(1)) /
pi_over180
sinAngle = Atn(xyny / Sqr(-xyny * xyny + 1)) / pi_over180


If sinAngle >= 0 Then
   strike180 = 180 - cosAngle
Else
   strike180 = 180 + cosAngle
End If

End Sub

Sub MakeUncertWorkbook(holeName)

    Workbooks.Open Filename:= _
        "uncert_plots.xls"

    ActiveWorkbook.SaveAs Filename:= _
        holeName & "_uncert_plots.xls", _
        FileFormat:=xlNormal, Password:="", WriteResPassword:="", _
        ReadOnlyRecommended:=False, CreateBackup:=False




End Sub

Sub SortUncertdata(holeName)

Dim i As Integer
Dim nofData As Integer

Windows(holeName & "_uncert_plots.xls").Activate

    Columns("A:B").Select
    Selection.Sort Key1:=Range("B1"), Order1:=xlDescending,
Header:=xlGuess, _
        OrderCustom:=1, MatchCase:=False, Orientation:=xlTopToBottom,
_
```

```
        DataOption1:=xlSortNormal
    Range("A1").Select

i = 0
While ActiveCell.Offset(i, 0) <> ""
i = i + 1
Wend

nofData = i

For i = 1 To nofData
   ActiveCell.Offset(i - 1, 2) = 1 - (i - 1) / (nofData - 1)
Next



End Sub


Sub CloseUncertWorkbook(holeName)

Windows(holeName & "_uncert_plots.xls").Activate

ActiveWorkbook.Save

Windows(holeName & "_uncert_plots.xls").Close

End Sub
```