Structural analysis of tectonic and sedimentary planes on cores

Examples of synthesis tables and plates for multi well study

2009

Fracture study: technical program

1.   Fracture logging

• **Type** of discontinuities,

• **Location** of structures, **distribution**, density, spacing, true frequency ,

• **Length** of features, **apertures**, **abutting**,

• First relative **orientation** and dip vs core axis, will be further calibrated with borehole images to re-orientate vs North (phase2).

• Description of mineralisations or in **fillings**

• **Data acquisition:**

Using AS3D, a Corias Direct 3-Dimensional electromagnetic digitisation tool

2.   Matching of core results to borehole images logs (FMI, UBI, etc...) or other avalaible data

3.   Interpretation, Managing

Comprehensive study with **deformation mechanisms and timing,**

Definition of **geomechanical units,**

- **Facies/deformation relationships** (fabric dependence),

- Relative **contribution to permeability** of different structure sets and preferential flowing vectors

- **Relationships** between fracture fillings, dissolution processes and available **diagenetic sequence**

4.   Integration of microtectonic results into existing regional knowledge.

Example: use of as3D to analyse old cores

Need only small working place in the lab

Possible to analyse slabbed cores and small core pieces

Searching connexion between two core pieces with saw cut and no marks

Quality control of connexion between slabbed core pieces

Example: use of as3D to analyse old cores

Selecting the fractured zones

Reconstruction and scribeline drawing

Cores ready for digitization

Data acquisition with AS3D

Example: use of as3D to analyse old cores

Data acquisition with AS3D

Selecting the fractured zones

Examples of erratic slabbing

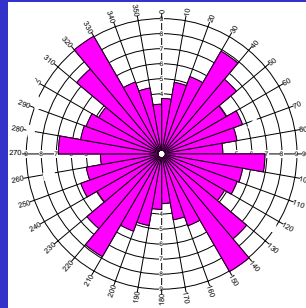# Example – Core vs image log : used for calibration
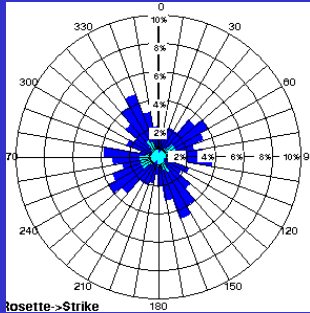
Image log data

Core data
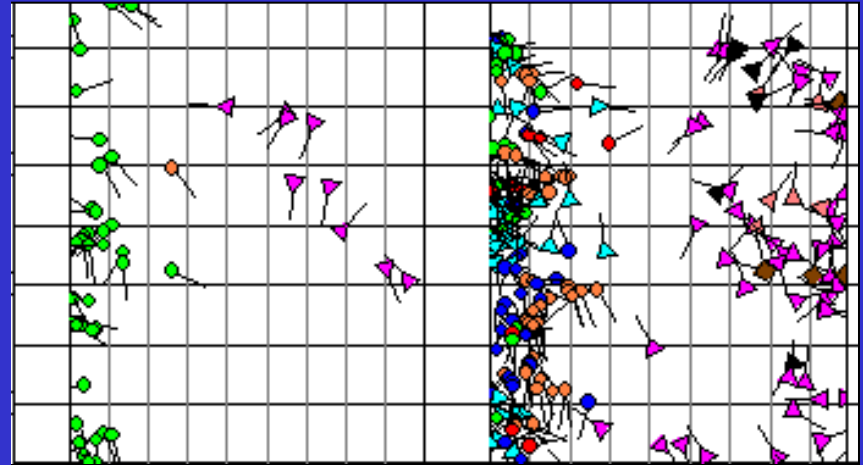
Same trend but more data and accurate description from cores

	A	B	C	D	E	F	G	H	I	J
1	Depth	Azimuth	Dip	Length	Depth	Nature	Thickness	Effective	Filling 1	Percent of
2	in feet				in meter			opening		filling 1
3	9515,866	206	8	9,6	2900,436	Stratification joint	2		A	100
4	9515,981	358	7	9,6	2900,471	Stratification joint	5		A	100
5	9516,470	157	13	9,8	2900,62	Disconformity	0,5		A	100
6	9516,532	111	3	9,5	2900,639	Disconformity	0,5		A	100
7	9517,087	215	19	10	2900,808	Disconformity	0,2		A	100
8	9517,264	126	85	5,1	2900,862	Partially open frac	0,1	0,02	G	100
9	9517,280	102	70	3,8	2900,867	Partially open frac	0,1	0,02	G	100
10	9517,326	125	68	4,1	2900,881	Partially open frac	0,1	0,02	G	100
11	9517,372	86	15	9,8	2900,895	Bedding				
12	9517,392	75	19	10	2900,901	Bedding				
13	9517,448	79	19	10	2900,918	Open Fracture				
14	9518,261	285	75	3,4	2901,166	Partially open frac	0,2		G	100
15	9518,271	109	84	3,8	2901,169	Partially open frac	0,2		G	100
16	9518,274	290	89	3,8	2901,17	Partially open frac	0,2		G	100
17	9518,894	82	17	9,9	2901,359	Bedding				
18	9518,960	94	15	9,8	2901,379	Bedding				
19	9519,150	105	11	9,7	2901,437	Disconformity	1		A	100
20	9519,485	202	2	9,5	2901,539	Stratification joint	0,5		A	100
21	9519,567	227	6	9,6	2901,564	Stratification joint	0,5		A	100
22	9519,573	240	3	9,5	2901,566	Stratification joint	0,5		A	100

90°

All data are stored immediately in the database
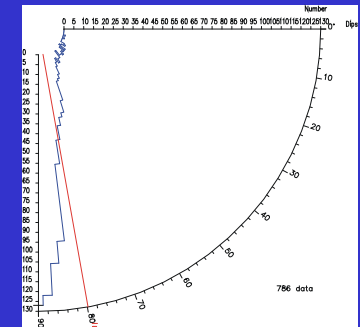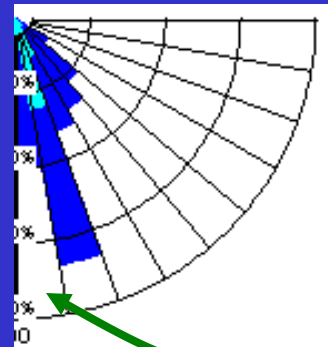
High dipping classes undetectable from images log (thin tension frac.)

Example – Synthesis table for multi-well reorientation

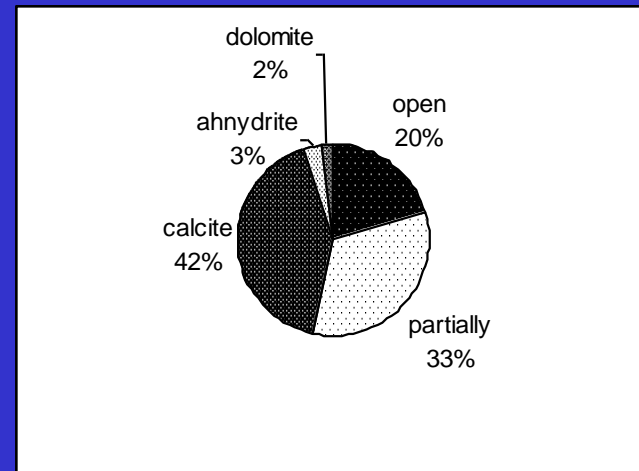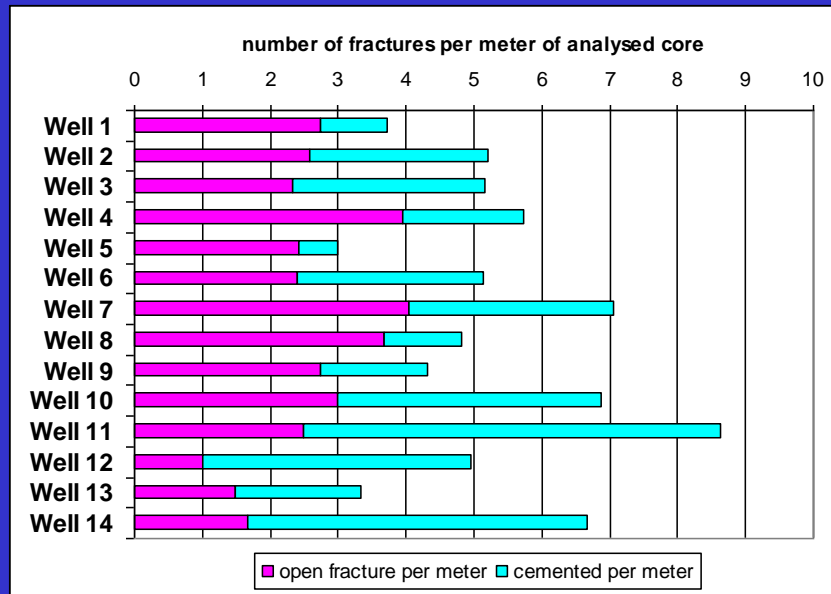| Well	Cores	length in m	Open fractures		Partially open fracture		Filled anhydrite		Filled calcite		Filled dolomlite		Induced		Bedding	
			Direction	Data	Direction	Data	Direction	Data	Direction	Data	Direction	Data	Direction	Data	Direction	Data
Well 1	5to9	48	N150	36	N150	96	N55(N155)	15	NW-SE(N155)	32		*	N150	17	SW	194
Well 2	2to7	42	N40	40	N30	68		*	N165	111		*	N25	36	WNW	116
Well 3	1and2	6	*	*	N25	14		*	N135(N50)	17		*	N35	3	NW	22
Well 4	3to6	77	N120	217	N125	88	N150	15	N135(N60)	121		*	N120	141	WNW	380
Well 5	3to8	56	N05(N145)	9	NE-SW(NW-SE)	127		*	N05(N140)	31		*	N20	140	S-SSE	195
Well 6	8to9	27	N15	10	N20	55	N55	4	NE-SW	70		*	N10	44	NW	59
Well 7	4to12	22	N135	13	N120	76		*	N100(N30)	66		*	N25	9	NW	142
Well 8	1to9	35	N125(ENE-WSW)	64	N125(ENE-WSW)	65	N125	4	NE-SW	36		*	N125	14	NNE	144
Well 9	1to5	28	N130(ENE-WSW)	36	N120 (N65)	41		*	ENE-WSW	44		*	N120	28	NE	129
Well 10	1to10	80	N120	110	N115	129	N110	42	N115	217	N115	51	N115	79	N	306
Well 11	1to4	37	N50(N120)	9	N120	83		*	N125	227		*	N120	23	N	272
Well 12	1	18	*	2	N60	16		*	ENE-WSW(NW-SE)	71		*	N70	3	N	174
Well 13	1 to 4	38	N30(N110)	11	N15 (WNW-ESE)	45	WNW-ESE	3	N115(N60)	68		*	N135	11	SW	174
Well 14	1	6	*	1	N105	9		*	ENE-WSW	30		*	*	4	S	6

All result from the reorientation are reported in a synthesis table and used for statistical analysis

Example – Multi well synthesis table for density of fractures by well

open fractures	partially open	all open and partially	calcite filled	anhydrite filled	dolomite filled	All cemented	core length	Wells		open fracture per meter	cemented per meter	all per meter
36	96	132	32	15		47	48	Well 1		3	1	4
40	68	108	111			111	42	Well 2		3	3	5
	14	14	17			17	6	Well 3		2	3	5
217	88	305	121	15		136	77	Well 4		4	2	6
9	127	136	31			31	56	Well 5		2	1	3
10	55	65	70	4		74	27	Well 6		2	3	5
13	76	89	66			66	22	Well 7		4	3	7
64	65	129	36	4		40	35	Well 8		4	1	5
36	41	77	44			44	28	Well 9		3	2	4
110	129	239	217	42	51	310	80	Well 10		3	4	7
9	83	92	227			227	37	Well 11		2	6	9
2	16	18	71			71	18	Well 12		1	4	5
11	45	56	68	3		71	38	Well 13		1	2	3
1	9	10	30			30	6	Well 14		2	5	7
558	912	1470	1141	83	51	1275	520		Mean	3	3	5

number of fractures per meter of analysed core

■ open fracture per meter ■ cemented per meter

dolomite 2%
open 20%
ahnydrite 3%
calcite 42%
partially 33%

Example – Synthesis rose diagrams of open, partially open, cemented and induced fractures plotted on seismic map
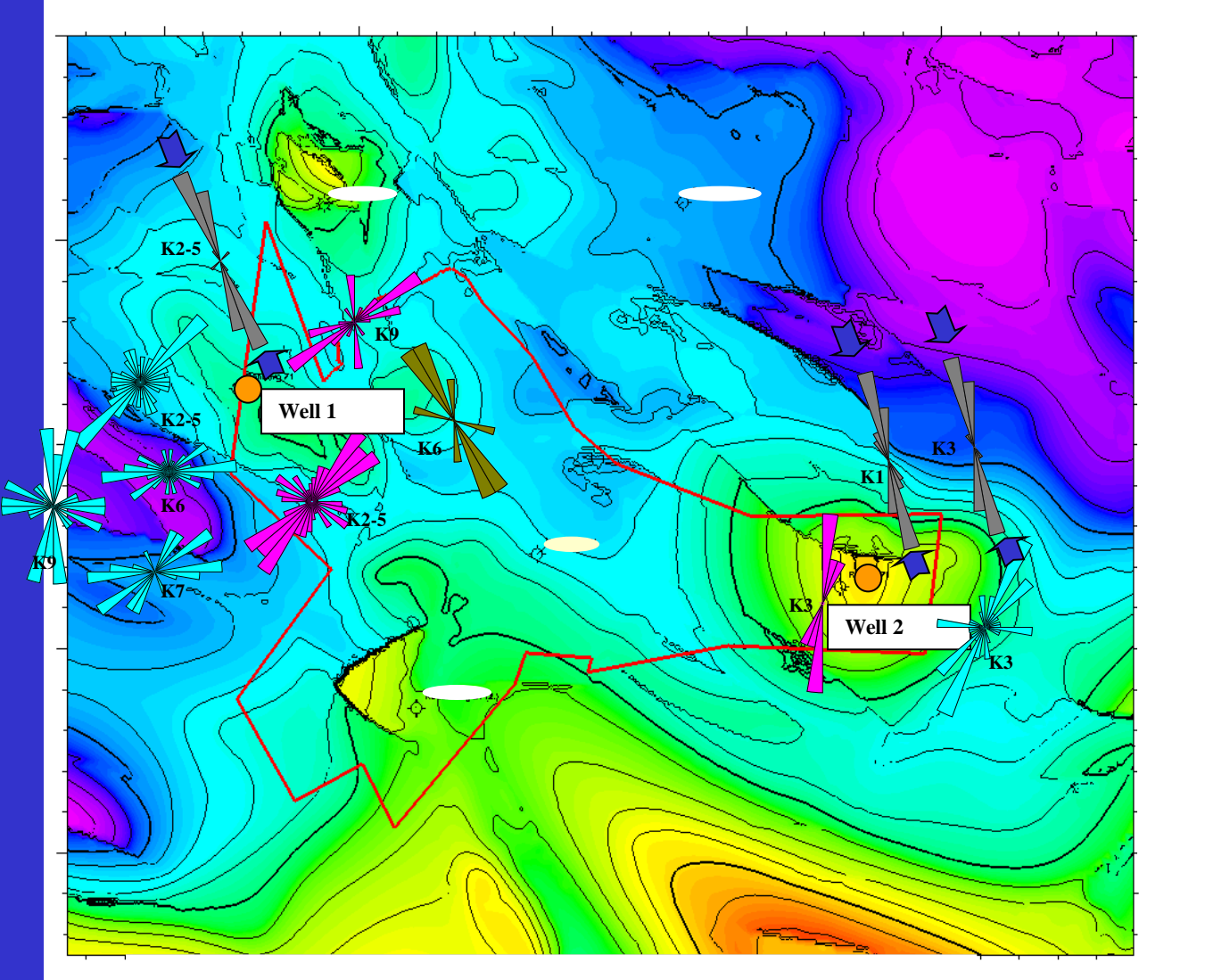
Rose diagrams for each type of fractures are reported on a synthesis map

Legend:
- Partially open fractures
- Open fractures
- Cemented gashes
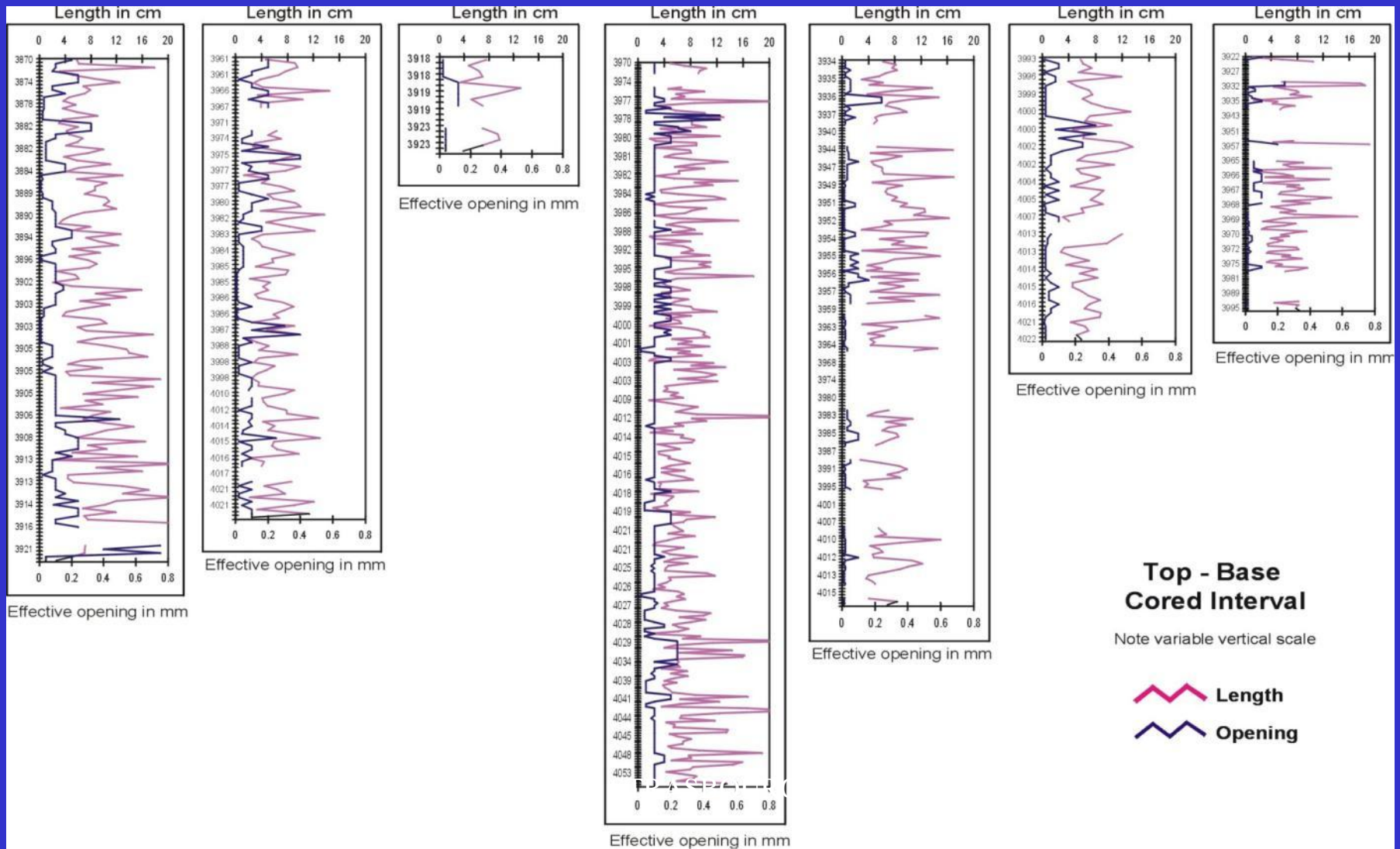- Induced fractures
- Actual horizontal stress

Example – Density logs for open and cemented fractures
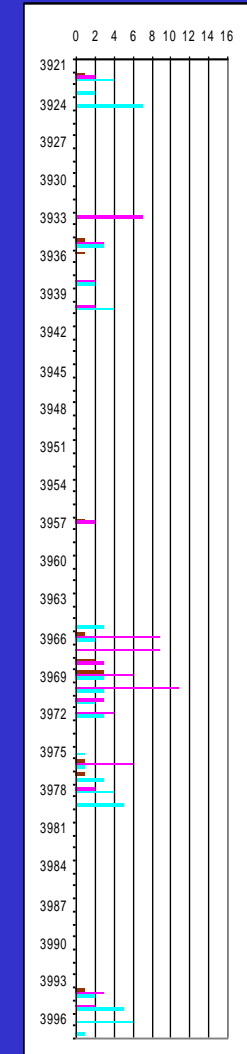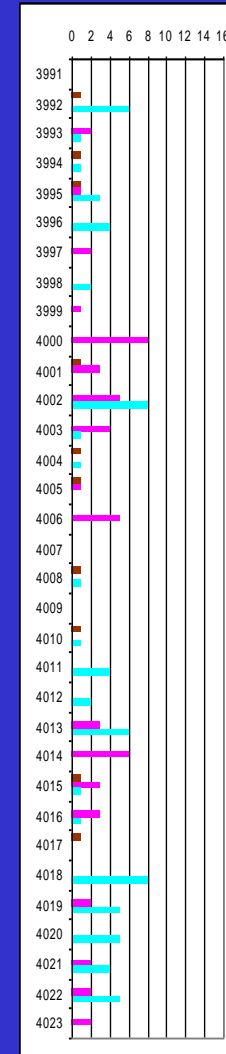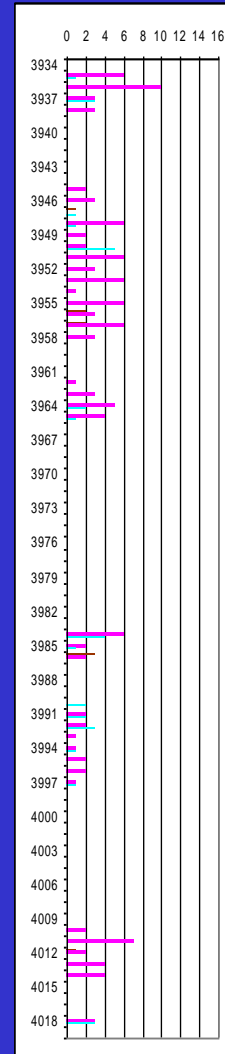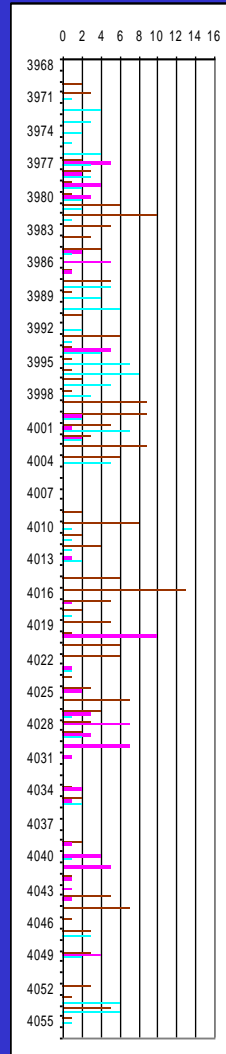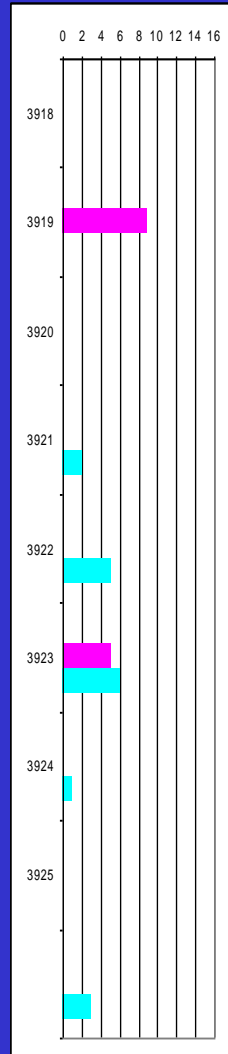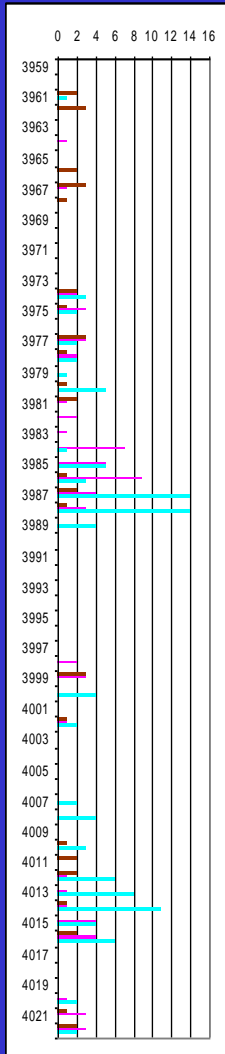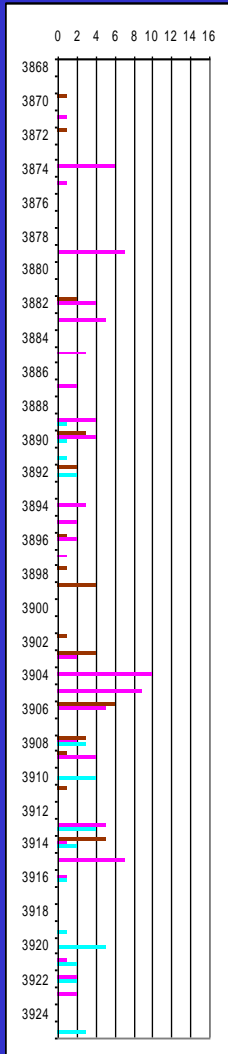
Open fractures   **Partially open fractures**   **Cemented gashes**

Example – Distribution of opening and length of fractures

Top - Base
Cored Interval

Note variable vertical scale

Length

Opening

Example - Distribution of opening and length

Length of fractures

Opening of fractures

Length of cemented gashes

Thickness of cemented gashes