Yucca Crest
Lathrop Wells Cone

David A. Ferrill

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12/20/1995

REGIONAL TECTONIC PROCESSES IN THE CENTRAL BASIN AND RANGE

SPECIFIC OBJECTIVES OF THIS RESEARCH CAN BE FOUND IN;

FERRILL, D.A. AND STIREWALT, G.L. 1995. PROJECT PLAN FOR RESEARCH ON TECTONIC PROCESSES IN THE CENTRAL BASIN AND RANGE REGION. CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES, SAN ANTONIO TX. REV. 0 CHANGE 3.

MATERIAL IN THIS NOTEBOOK CONCENTRATES ON FIELD NOTES, PRINCIPALLY TAKEN WHILE CONDUCTING FIELD WORK FOR TASK 4 OF THE TECTONICS RESEARCH PROJECT

TASK 4: FIELD INVESTIGATIONS TO ASSESS ESTIMATES OF LATE NEOGENE AND QUATERNARY STRAIN AND TO SUPPORT DEVELOPMENT AND ASSESSMENT OF ALTERNATIVE TECTONIC MODELS OF LATE NEOGENE THROUGH QUATERNARY, AND CONTEMPORARY TECTONIC DEVELOPMENT OF THE CENTRAL BASIN AND RANGE REGION.

ENTRIES ON PAGES 1-146 WERE ALL MADE ON 20 DECEMBER 1995. THESE PAGES ARE ALL PHOTOCOPIES OF FIELD NOTES. FIELD NOTEBOOK PAGES EACH HAVE FIELD NOTEBOOK PAGE NUMBERS AND DATES OF ENTRIES. INTO FIELD NOTEBOOK NEW DATES WILL NOT BE ASSIGNED HERE.

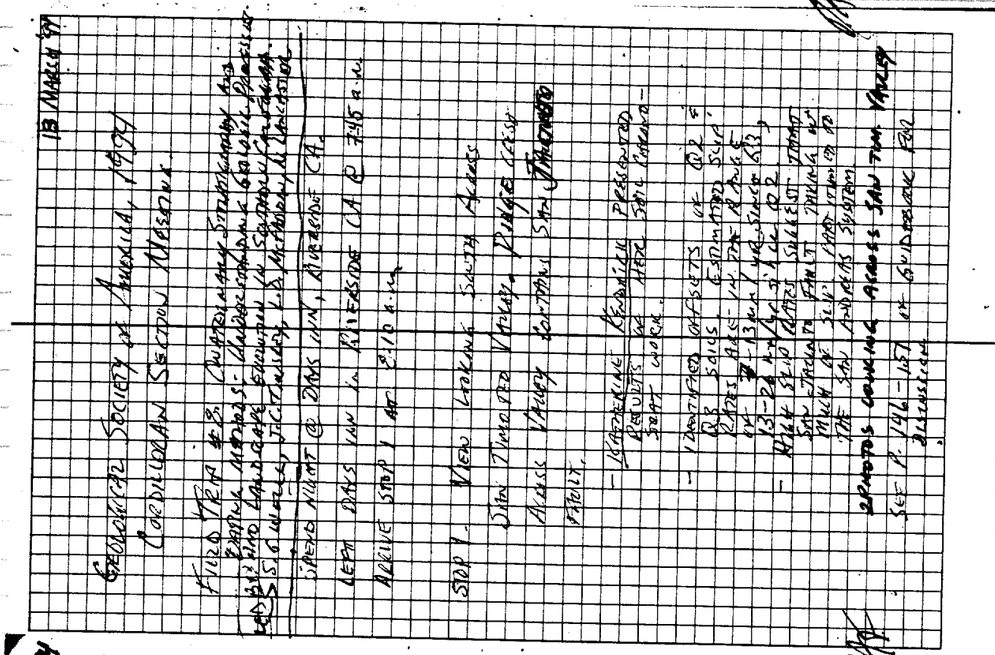
David A. Ferrill

12/20/95

THIS NOTEBOOK HAS ~~TWO~~ ONE ATTACHMENTS:

1. GEOLOGIC MAP OF BARE MOUNTAIN.

↳ Monsen, S.A., Carr, M.D., Reheis, M.C., and Orkild, P.A. 1992. Geologic Map of Bare Mountain, Nye County, Nevada: U.S. Geological Survey Miscellaneous Investigations Series, Map I-2201. Reston, VA: USGS.



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2

3/18/94

DISCUSSION IN VAN BETWEEN (UNFAMILIAR) STOPS.

DAVE RICHTMER SAYS (THAT SAN ANDREAS HAS ~36 mm/yr SLIP AND THAT THIS IS FAIRLY CONSISTENT THROUGH STATE. SOUTH OF CAJON PASS, THE SLIP IS PARTITIONED ONTO THE SAN JACINTO FAULT (~10 mm/yr) AND THE SAN ANDREAS FAULT (~26 mm/yr.) THE TWO FAULTS JOIN N. OF CAJON PASS, JUST WEST OF WRIGHTWOOD, CA.

STOP 2. TRENCHES ON SAN ANDREAS FAULT.

PRESENTATION BY GORDON SEITZ.

→ SEE P. 152–156 OF GUIDEBOOK

PHOTOS. • LOOKING S. ALONG HWY 215.

• ZOOMED VIEW LOOKING S. ALONG 215 (FROM SHUTTER RIDGE MARKED ON p. 153).

• GAP IN LANDSLIDE RIDGE, S. OF SHUTTER RIDGE, MARKING ACTIVE TRACE OF SAN ANDREAS FAULT.

• ZOOMED VIEW OF ABOVE.

• SAN ANDREAS FAULT (GAP)

3/18/94 3

(PHOTOS CONT'D)

N. OF SHUTTERRIDGE.

• SAME AS ABOVE, ZOOMED VIEW.

NOTE: THERE ARE TWO TRACES OF THE SAN ANDREAS FAULT AT THIS LOCATION. THE TRENCHES ARE ACROSS THE MORE ACTIVE TRACE.

– VEGETATION CHANGE ACROSS FAULT ATTRIBUTED TO FAULT ACTING AS BARRIER TO GROUNDWATER FLOW FROM UPHILL SIDE AND PONDING OF GROUNDWATER (UPHILL).

• SEVERAL PHOTOS OF 3 TRENCHES IN VARIOUS STAGES OF COMPLETION AND LOGGING

(PHOTO 18)

STOP 3. – SAN ANDREAS FAULT – SOIL CHRONOSEQUENCES

LES MCFADDEN & BRUCE HARRISON

• PHOTO 19. – STEVE WELLS, BRUCE HARRISON, LES MCFADDEN.

4. 3/18/94

– WORK OF MCFADDEN & WELDON (1987) AND MEISLING & WELDON (1989) REFERRED TO IN PRESENTATION. (STRATIGRAPHIC INFO.).

COMMENTS ABOUT "SOIL" DEVELOPMENT – BRUCE HARRISON & LES MCFADDEN

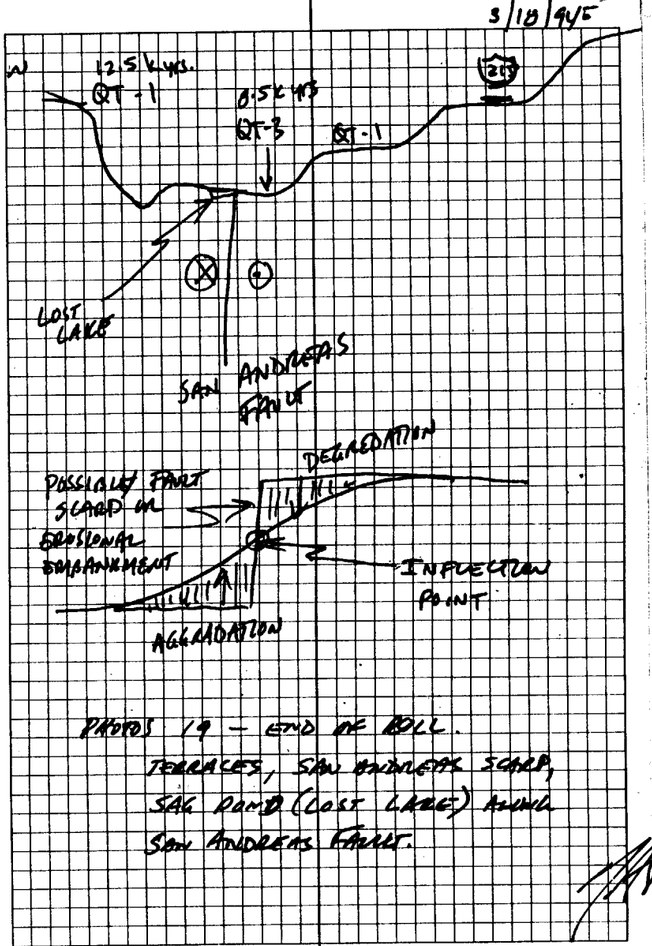
– SOILS LARGELY A FUNCTION OF WINDBLOWN SILT & CLAY THICKER DEPOSITION. (BY SHEETWASH, FLOW, WIND, ...).

– DEPOSITION MAKES THESE SOILS APPEAR TO BE MORE STRONGLY DEVELOPED.

– IMPORTANT TRANSITION OCCURS AT POINT OF INFLECTION ON SLOPE (TERRACE EDGE) EROSION ABOVE AND DEPOSITION BELOW.

– SOILS HERE (~~HORIZONS A, B, C, ...~~) ARE TOTALLY DIFFERENT FROM TEXTBOOK DESCRIPTIONS OF SOIL HORIZONS (A, B, C, ...)

3/18/94 5



PHOTOS 19 – END OF ROLL.

TERRACES, SAN ANDREAS SCARP, SAG POND (LOST LAKE) ALONG SAN ANDREAS FAULT.

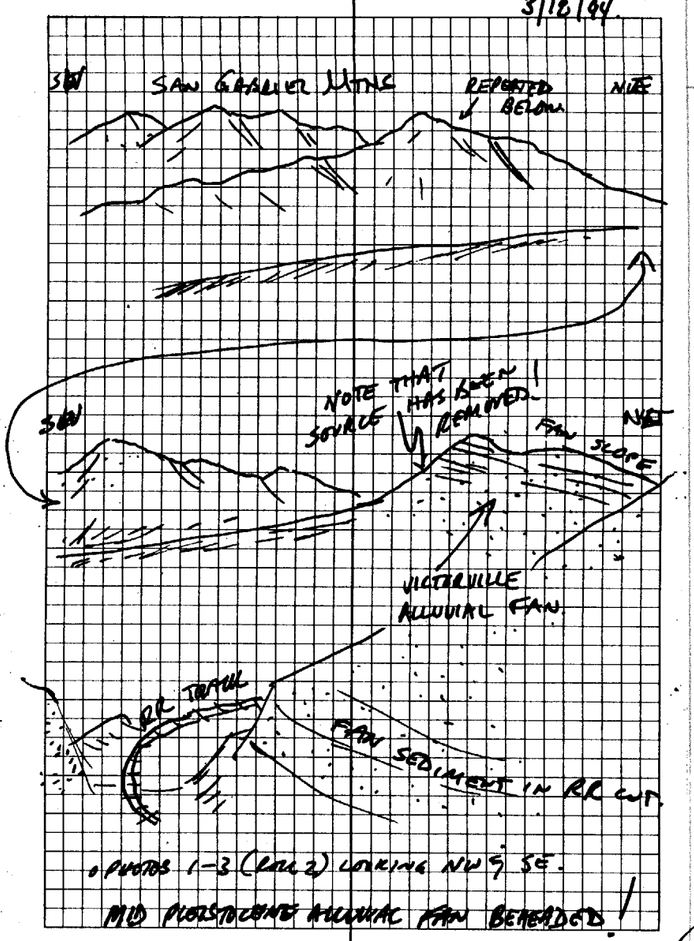
3/18/94

STOP 4 – CAJON PASS

DRAINAGE DIVIDE B/W MOJAVE DESERT (INTERNALLY DRAINED) AND CAJON CANYON.

- SEE MEISLING & WELDON'S WORK ON STRATIGRAPHY HERE.
- SEE LOOSE STRAT. COLUMN HANDOUT FOR DISCUSSION OVERVIEW OF STRAT. CORRELATIONS.
- GUIDEBOOK P. 160 – 164.
- SAN ANDREAS SLIP = 36mm/yr HERE.
- VICTORVILLE ALLUVIAL FAN – BUILT NORTHEASTWARD FROM CAJON PASS AREA. UPPER PART IS UPPER PLEISTOCENE. VICTORVILLE FAN NOW DEAD. DRAINAGE HAS FLIPPED BACK AND FORTH THROUGH TIME.

3/18/94



- PHOTOS 1–3 (ROLL 2) LOOKING NW & SE.

MID PLEISTOCENE ALLUVIAL FAN BEHEADED!

3/18/94

STOP 5. BRASS VALLEY CREEK – HEADWATERS OF MOJAVE RIVER. STOVE WELLS & TANYA WILLIAMSON

- PREVIOUS WORK HERE BY CHRIS MEISLING AND RAY WELDON.

SPEND NIGHT @ BEST WESTERN IN VICTORVILLE, CA.

AFTER SUPPER, ROLLED OUT DTM w/ EPICENTERS & NAVATA ET AL. FAULTS. AZKO CONVERTED TOPOGRAPHY W/ "ALL FAULTS".

LOTS OF INTEREST, NOTED THAT RECENT LANDERS FAULTING IS INCLUDED ON "ALL FAULTS" MAP.

LANDERS HYPOCENTERS DISPLAYS ALSO WELL RECEIVED.

3/19/94

DAY 2 OF QUATERNARY STRATIGRAPHY AND DATING FIELD TRIP.

STOP 2.1 MOJAVE RIVER, ACTUALLY FLOWING. PRESENTATION BY USGS HYDRO PEOPLE. MONITORING WELLS PLACED TO STUDY REGIONAL AQUIFER WHICH IS APPARENTLY NOT BEING RECHARGED BY MOJAVE RIVER AND MAY NOT BE UNDER SIGNIFICANT RECHARGE FROM ANY SOURCE. WATER CHEMISTRY SUGGESTS VERY OLD WATER IN "DEEPER" REGIONAL AQUIFER.

- PHOTOS OF MOJAVE RIVER.

STOP 2.2 MOJAVE RIVER N.E. OF BARSTOW CA.

- PHOTOS OF GRAVEL RIDGE (RIGHT LATERAL) OFFSET ~ 50 M BY CAMP ROCK FAULT. CALICO MTNS. IN DISTANT BACKGROUND. VIEW LOOKING NORTH.

10 3/19/94

STOP 2.3 - SAND RAMP NEAR SITE OF FORT CADY; ~~SOLDIER~~ MTN. CONE OF CADY MTNS.

- SAND BLOWN UP AGAINST W. SIDE OF MTN.
- LUMINESCENCE TECHNIQUES HAVE BEEN USED HERE AND YIELDED SOMEWHAT DUBIOUS RESULTS.
- SOME ALLUVIAL & COLLUVIAL MATERIAL MIXED IN W/ LARGE-SCALE CROSSBEDDED EOLIAN SAND.
- NICK LANCASTER HAS DONE THE LUMINESCENCE WORK HERE AND LED THIS STOP (MENTIONED DATE NEAR BOTTOM OF DUNES ~20 KYRS → MENTIONED DATE NEAR TOP OF DUNES ~10-15 KYR)
- PLEISTOCENE LAKE MANIX SHORELINE DEPOSITS ARE PRESENT AT THE BASE OF THIS SAND RAMP, ACCORDING TO NORMAN MEEKS (GRAD. ST. SAN BERNARDINO) WHO DID THE P.D. ON LAKE MANIX.
- STOP IS AT BEARTOOTH MINES

o PHOTOS OF CROSS BEDDING IN EOLIAN SAND.

o PHOTO'S OF SWOLLEN BEARTOOTH.

11 3/19/94

STOP 2.4 - AFTER LUNCH - EDGE OF NOW-DRAINED LAKE MANIX NEAR MOUTH OF AFTON CANYON.

- VIEWS OF HILLSIDE EXPOSURES OF MANIX FORMATION AND MOJAVE RIVER FORMATION.

o PHOTOS OF MOUTH OF AFTON CANYON AND SOUTH.

- MOUTH PART - LEFT-LATERAL STRIKE SLIP FAULT

STOP 2.5 - SODA BASIN NEAR BAKER CA

SUPPER @ ZZYZX, NEAR BAKER CA

12 3/20/94

DAY 3 OF QUATERNARY STRATIGRAPHY AND DATING FIELD TRIP.

STOP 3.1

CIMA VOLCANIC FIELD - EASTERN EDGE OF MOJAVE BLOCK (E. CALIFORNIA SHEAR ZONE), → BLACK TANK CONE

- MIOCENE AND YOUNGER
- ~40 VOLCANIC FLOWS AND 60 CENTERS
- ~8 M.Y. AND YOUNGER - WE ARE STANDING ON YOUNGEST CALDERA CONE, BLACK TANK CONE.

o PHOTO 22 (ROLL 2) TOWARD END OF ROLL.

o BEGINNING OF ROLL 3

- BASE AGE OF YOUNGEST CINDER CONE IN CRATER FLAT REVISED, BASED ON USING CIMA AS AN

13 3/20/94

ANALOGUE, FROM 300 KYRS TO 30 KYRS. (LATHROP WELLS) → OR YOUNGER, EVEN HOLOCENE.

- GEOMORPHIC EVIDENCE.
- SOIL CHRONOSEQUENCES.
- AGES RANGE FROM 20 000 YRS IN FUTURE TO 900 000 YRS IN PAST (20-30 MOVEMENTS) FROM LATHROP WELLS.

JOHN COSSMAN HAS DONE PROTEIN DATING HERE, WHICH SUGGESTS DIFFERENT AGES FOR FLOWS.

- DIFFICULT TO PIN DOWN AGES.
- BETTER TO USE SOLID FLOWS RATHER THAN DOMES. ALSO, CLAY-RICH SURFACES CONFUSE THE PALEOMAG SIGNATURE

VAN RIDE TO STOP?

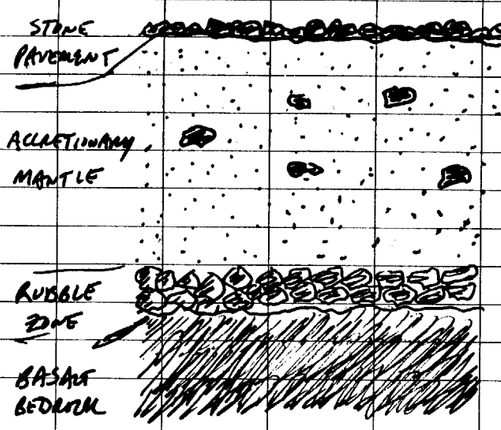
GARLOCK FAULT INITIATED 8-12 MYA.

→ DAVE RICHTER SAYS NOT. SEE MCCALL'S WORK

14 3/20/94

STOP 3.2 - CIMA VOLCANIC FIELD

ARGUMENT THAT PAVEMENT DEVELOPED W/ SOIL BELOW, NOT BY DEFLATION, BUT INSTEAD BY ACCUMULATION OF SILT, CLAY, (WINDBLOWN) → & FINE SAND, ~~[illegible]~~ LIFTING OF "PEBBLES", AND INFILTRATION DOWNWARD OF WINBLOWN F.G. SEDIMENT INTO DESSICATION CRACKS (POLYGONAL SPRINGTUBE SEEN BELOW PAVEMENT WHEN DRY.



15 3/20/94

COSMOGENIC DATING - SURFACE EXPOSURE DATING.

LUNCH @ KELSO RR STATION (TRAPPED BY TRAIN)

STOP 3.3 - QUATERNARY STRATIGRAPHY OF THE PROVIDENCE MTNS. & PIEDMONT.
STUDY OF SOIL DEVELOPMENT ON ANNUAL FANS SOURCED FROM DIFFERENT PARTS OF RANGE -
- LIMESTONE
- ~~QUARTZITES~~ GRANITIC
- METAVOLCANICS

16

17 3/24/94

LANDERS : EARTHQUAKE & AFTERSHOCKS

3/24-25/94.

- OFFICIAL LEADER BOB REYNOLDS IS ILL; FRANK JORDAN (COLEADER) IS ACTING LEADER. OTHER COLEADER, RICK GUNDRY.

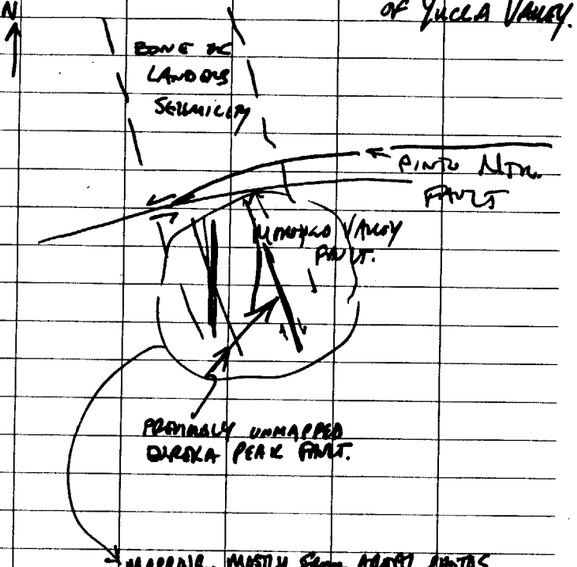
STOP 0.1 UNOFFICIAL STOP TO LOOK AT TRENCH THROUGH THRUST FAULT. SAN GORGONIO PASS FAULT (ENE TRENDING) TO ENE TIES INTO BANNING FAULT, S. BRANCH OF SAN ANDREAS FAULT.

STOP 0.2 - SURFACE RUPTURE OF BANNING FAULT OFFSETTING CURBS / ROADWAY AND MARKED BY "GRASS" ALIGNMENTS ON MEDIAN. STOP AT BANNING FAULT AND HWY 62 INTERSECTION, W. OF DESERT HOT SPRINGS.

18 3/24/94

STOP 0.3.

INTERSECTION OF PINTO MTN. AND MIRAGE VALLEY FAULTS - WEST SIDE OF YUCCA VALLEY.



DISCUSSED ZONING REGULATIONS -
- VARY B/W COUNTY TO COUNTY.
- MAP HOLOCENE FAULTS.
- BUILDING SETBACK USUALLY 50+ FT.

3/24/94 19

STOP 1 - BOULDER ALLEY IN YUCCA VALLEY - EAST WALL CULVERTED DURING LANDERS EARTHQUAKE. (RECORDED ON TOWN VIDEOTAPE).

STOP 2 - BURNT MESA RD. - N. YUCCA VALLEY. 2-3 MILES S. OF EPICENTER. CRACKS IN ROAD (PHOTOS OF CRACKS). S. END PROTECTION OF JOHNSON VALLEY FAULT.

STOP 3 - REECHE RD. @ ACOMA TR. OFFSET ROAD (9') AND LINES OF TELEPHONE/POWER POLES

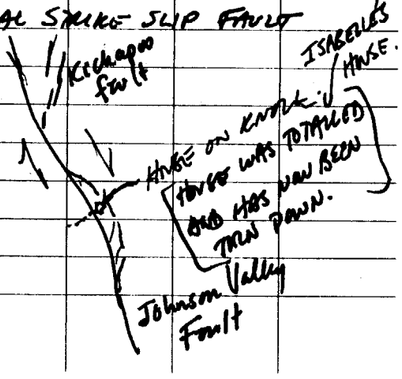
STOP 4 - HOUSE, YARD, ~~ETC~~ DEFORMED ALONG S. JOHNSON VALLEY FAULT. FRUIT TREES KILLED BY FAULT CUTTING ROOTS. SURFACE RUPTURE APPARENTLY RAVELED AROUND ROOT SYSTEMS FOR FRUIT TREES (STILL KILLED TREES). WATER PIPE SEPARATED, 23 FEET FROM SHED (ACTUALLY SHED SEP. FROM PIPE). EAST/WEST DIRT ROAD W. OF ACOMA RD.

20 3/24/94

NOTE: SPECIAL STUDY ZONE MAPS CAN BE GOTTEN FROM BLUEPRINT SERVICE CO. - SAN FRANCISCO. (~$2/EACH).

CALIFORNIA DIVISION OF MINES & GEOLOGY - SPECIAL PUBLICATION No. 42. ($3.)
FAULT RUPTURE ZONES OF CALIFORNIA - DISCUSSES THE LAW AND INCLUDES LIST OF MAPS.

STOP 5 - GRANITE EXPOSED IN PRESSURE RIDGE BOUNDED E AND W. BY FAULTS. LEFT STEP ON RIGHT LATERAL STRIKE SLIP FAULT



3/24/94 21

STOP 6 - HOUSE SITE ON KICKAPOO FAULT. 3 TRENCHES ACROSS SURFACE RUPTURE. ## LOCATION OF STOP 4 IN CALIFORNIA GEOLOGY JAN/FEB 93 ISSUE.

STOP 7 - NO - LUNCH STOP

STOP 8 - EMERSON FAULT SCARP.
VERTICAL - ~ 3' - 4.5'
HORIZONTAL - 20.6' RIGHT LATERAL
~~DEXTRAL~~
- FAULT DIP CHANGES ALONG STRIKE, THEREFORE DISPLACEMENT IS LOCALLY NORMAL OBLIQUE OR REVERSE OBLIQUE (RIGHT LATERAL)
- FAULT PERPENDICULAR

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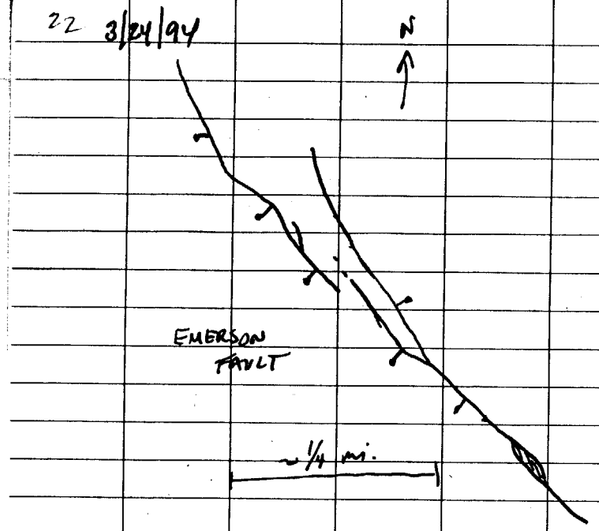


STOP 9 - EMERSON FAULT ON EAST SIDE OF RIDGE IMMEDIATELY ACROSS VALLEY & NORTH OF STOP 8. OFFSET STREAM, WELL EXPOSED SCARP IN WEATHERED GRANITIC ROCK

3/24/94 23

NOTE: EARL HART (CHIEF GEOLOGIST), GEOLOGIST WORKING FOR THE STATE, WAS HEAVILY INVOLVED IN MAPPING OF SURFACE RUPTURE IN CONJUNCTION W/ USGS.

- NEED TO TALK TO HIM ABOUT GETTING COPIES OF MAPS
- ED KIESSLING, ALSO WITH THE STATE, SAYS THAT HIS FIELD HYPOCENTER DATABASE MAY BE AVAILABLE FROM CALTECH.

8 p.m. ARRIVED AT CAMP, NOT YET DARK - AND LUNCH OR SUPPER (OR BREAKFAST). DID HAVE 3 pm SNACK TOO.

24 3/24/94

CONVERSATION W/ EARL HART.

- KATE HUTTON @ CALTECH PROBABLY HAS LANDERS DETAILED HYPOCENTER DATA. (SEISMOLOGIST)
- LUCILLE JONES - U.S.G.S. PASADENA

→ BOTH PART OF CALTECH/USGS SEISMOLOGY OFFICE.

- FTP SITE @ CALTECH.
- KERRY SIEH @ CALTECH - HANDING MAPPING FROM LANDERS RUPTURE. DIGITIZING. MAY NOT BE READY TO RELEASE TO PUBLIC.
  - EARLS MAPS ARE BETTER BUT NOT FINISHED, & NOT DIGITIZED.

→ QUESTION FOR EARL HART - STATUS OF 1992 REVISION / POST LANDERS REVISION.

3/25/94 25

DAY 2 - LANDERS FIELD TRIP

STOP 1 - RAINBOW BASIN

SYNCLINE, ANTICLINE, ANGULAR UNCONFORMITY, MINOR DEFORMATION AND EXTENSIONAL FAULTS IN FOLD LIMBS.

STOP 2 - WATERMAN HILLS DISPLACEMENT - RHYOLITE (~19 MA) OVER WATERMAN GNEISS. FAULT ZONE FABRIC IN UPPER PART OF WATERMAN GNEISS.

~DUE NORTH OF BARSTOW.

STOPS 3 & 4 - NEWBERRY FRACTURE ZONE. GRABEN FORMING SURFACE RUPTURES.

DISAGREEMENT OVER WHETHER RESULT OF COMPACTION (STRUCTURED) OR FAULTS

Information on Pages 16 through 30 is not U.S. Nuclear Regulatory Commission-Yucca Mountain-related information and is therefore not included in this file.

56 MAY 2, 1994

DOE - NRC SITE VISIT - CHARACTERIZATION OF FAULTS AND FRACTURES NEAR YUCCA MTN., AND STRATIGRAPHY, STRUCTURE AND ROCK PROPERTIES ALONG THE EXPLORATORY STUDIES FACILITY NORTH RAMP. MAY 2-5 1994.

→ FLEW INTO LAS VEGAS @ n/pm ON SUNDAY MAY 1, 1994.

→ VISITED RED ROCKS AND TOWN OF BLUE DIAMOND ON WAY TO PAHRUMP, NV. STAYING @ DAYS INN IN PAHRUMP.

→ MORNING PRESENTATIONS IN OFFICE @ NTS

→ AFTERNOON VISIT TO ESF

2 MAY 1994. 57

PIECES OF TUNNEL BORING MACHINES CURRENTLY ARE CURRENTLY BEING COLLECTED AT ESF LOCATION.

- BORING MACHINE WILL BORE 25' DIAMETER TUNNEL.
- MACHINE WILL BE ~475' LONG.
- MACHINE EXPECTED TO BORE 375'/WEEK @ 5 DAYS/WK, 3 SHIFTS/DAY
- MACHINE WILL HAVE LUNCH FACILITIES ETC. ON BOARD.
- ROLLING "CUTTERS" ALONG EDGE DON'T CUT BUT IN STEAD CRACK NOT ROCK OR REMOVE SMALL PIECES ≤ 1 FT. SIZE.
- CUTTERS WILL BE VISUALLY INSPECTED FOR WEAR (FROM BACK MACHINE - PERSON INSPECTS BY WALKING OUT FRONT END).

58 2 May 1994

- FRAGMENTS EXTRACTED FROM CUT FACE BY CONVEYOR SYSTEM.
- RATE OF ROTATION UP TO 6.5 RPM. ADJUSTED ACCORDING TO MATERIAL (REDUCED TORQUE, AVOID "GUMMING UP" MACHINE)
- INSTANTANEOUS RATE (IDEAL CONDITION) ~ 16 FT./HR. (IN GRANITE).

3 May 1994 59

DAY 2 OF DOE-NRC TECHNICAL EXCHANGE

MARK TYNAN - 8:00 a.m.
SEISMIC PROGRAM.
- REDUCED FLM. 5 TO 2 cm-ft
- NO REP FILED YET.
- TRIAXIAL GEOPHONE PACKAGE IN BAM.
- VIBROSEIS + (DYNAMITE?) EXPLOSIVE SOURCE

JOHN WHITNEY -
WINDY WASH FAULT
-
- .008 mm/yr – .016 or .013 mm/yr

QUAT. RATES - PAHRANAGAT CANYON .01 - .02 mm/yr.
BOW RANGE .001 - .03
SOL. CAN. .01
SPACER R. .005 - .02
WINDY WASH .008 - .016.

3.7 Ma slip rate
.03 mm/yr
"Long term rate"

CONCLUDE THAT QUAT RATES NOT SIGN. DIFF. F/m "LONG TERM"

60 3 May 1994
RATES OF FAULT OFFSET @ YM

13 - 11.5 Ma .07 - .45 mm/yr (SCOTT CHAP)
11.5 Ma - PRES. .01 - .029 mm/yr (SCOTT

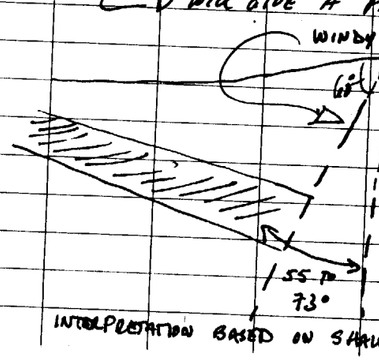
RATES ↑ F/m NW TO SE

3.7 Ma - PRESENT .03 mm/yr

ESSENTIALLY CONSTANT RATE OVER LAST 11 Ma.

NEW FAULT MAP IN PAPERS (YM). WILL BE RELEASED AS WE.

D WILL GIVE A PREPRINT.



INTERPRETATION BASED ON SHARAN SEISMIC.

3 May 1994 61

- MAY WANT TO TALK TO WHITNEY ABOUT HIS INTERP. OF FAULTS AS GREATER DEPTH.

CHRIS RAUTMAN -
- STATUS OF SYSTEMATIC DRILLING PROGRAM
- STRATIGR. PROGRAM (OF DRILLING 12 WELLS) WITH DRILLING SOIL.
- THOSE WELLS ARE IN IMMEDIATE VICINITY OF ESF

JOHN RYE
- USE OF SITE DATA IN ESF DESIGN.

CHRIS MENGES -
- DISCUSSING FAULT SEALING @ YM. - Branching - Sealing?
- BASE MTN TRENCH 1 → LARRY ANDERSON WILL DISCUSS IN TRIP.
- BASALTIC ASH HAS BEEN FOUND IN FAULTS NEAR SOLITARIO CANYON FAULT (T8) AND PAHRANAGAT CANYON FAULT?

62 3 MAY 1994

PAHRANAGAT CANYON FAULT

BUSTED BOTTE

430 ± 110
222 ± 10
146 ± 8
97 ± 9
36 ± 10 TL

} U-Th

STAGECOACH RD. FAULT

CROSSES PART THROUGH SCR-T3.

87 ± 18 TL
20 ± 2 U-Th rhizoliths
108 ± 10 U-Th
23 ± 5
38 ± 5 } TL

↖ U. Shallow - suspect sample - should be Holocene. Too old

CENTRAL PART SCR-T3

24 ± 3
20 ± 2 } U-Th.

problematical → too young?

4.9 ± 34
11. ± 6
28 ± 4 } TL

63 3 MAY 1994

* ASHES SEEN IN SCR-T3 may correlate w/ LATTER TWO EVENTS.

DISPL. MAG.		NET DISP (cm)	COMP (cm)
PBC	MWV-TY		190-270
	BBWATE	>480-590	2460-580
BR		50-130	45-50
SCR	SCR-T1	60-190	65-210
	SCR-T3	110-240	135-290

REC. INTVL & SLIP RATE FAULT	SITE	RECURRENCE INTVL (ky)	SLIP RATE (mm/yr)
PBC	MWV-TY	30-80	≤0.01
"	BUSTED BUTTE	40-140	.01-.02
BARN RIDGE	TRENCH 14D	40-80	.001-.003
SCR-	SCR-T1	10-50	.02-.04
"	SCR T3	10-50	.02-.05

FAULT	SITE	∞ AGE MRE (ky)	ASH PRESENT
PBC	MWV TY	10 (0-15)	NONE REC
PBC	BB	10 (30-140)	YES !!? LATER
PBC	AT RUSTLER	10?	YES I-II-?
BR	TRENCH 14D	10 (50-80)	YES/TY ASH
SCR	SCR T1, T3	6 HIs (5-20)	YES II-III? LAT
SC	TRENCH T8 SCF-T1	10 (15-100)	YES I-II-III.

THOMAS B. ASH ANALYSIS NOT COMPLETED - LOOK LIKE PUMA-MULTIFALL ASH. OTHERS SAYS GOOD EVIDENCE HERE OF ~60-70 ka ASH (MAYBE BISHOP). TENTATIVE INTERPRETATIONS / FAVORITE MAY CHANGE WITH EXAMINATION.

ASH LAYER @ LATTER WELL.

64 3 MAY 94

JOHN WELLING -

- STRATIG OF MOUNTAIN VALLEY STUDIES.

CHRIS FRIDRICH

- SAYS SUBSURFACE IS "TRIVIAL." WE WORK NEED TO BE ON THIS.
- NO 3D UNDERSTANDING OF RANGE-VALLEY YUCCA MTN FAULT SYSTEM.
- FISSION TRACK WORK (etc...) BEING DONE BY TOM HOLSEN 9? @ UNIV. OF ARIZONA.
- OBSERVES (EVOR, NORMAL) SLIP SLICKS ON S. BASE MTN. FAULT. RL SLIP INFERRED IN NORTH YM SYSTEM BOUNDING FAULT.

CHRIS MAHER DAF

TIMBER MTN. ... etc ... CALDERA.

BM

~0-10° PALEOMAG ROTATION

~30° PALEOMAG. ROTATION

65 3 MAY 1994

- FRIDRICH SAYS THAT NORTHERN YUCCA MTN. SYSTEM BOUNDARY IS RL SSLIP FAULT, PINNED @ PAHUT PASS. THIS PINNING AT PAHUT PASS IS HIS BASIS FOR FAULT DAF) AND INTERPRETED EXTENSION ON THAT NORTH SIDE OF FAULT (BASED ON DIPS AND CLOSELY SPACED FAULTS), VS HIS BASIS FOR THE RL SLIP.

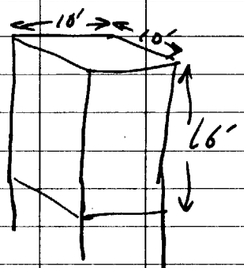
CHRIS MAHER

66 3 May 1994

Fran Ridge - Pavement 2001 & Large Block Experiment.

Topopah Springs Tuff - Paintbrush GP (Topopah Orange Brick on Scott & Bonk 1984).
→ Middle - Non Lithophysal
→ Upper - Lithophysal

Large Block -



- Detailed analysis of thermal effects on block.
- Just beginning to excavate block. 2' cut around block complete - to depth of 16'?

3 May 1994 67

Pavement Exposure on Ghost Dance Fault

- Tera Canyon Tuff in Paintbrush GP
- Ghost Dance Fault exposed on excavated pavement - trending N-S, dipping ~85°W. w/ ~55' down to west displacement
- Walking to ridge crest along fault. Breccia exposed at scattered outcrop. Must need to know detailed stratigraphy to identify offset across fault.
- Other faults discovered at this exposure upon excavation of pavement.

68 4 May 1994

5 May 1994 69

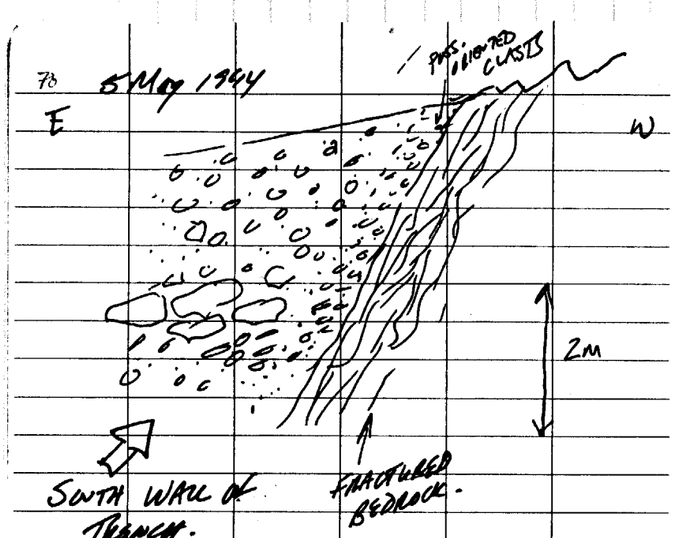
Trenches Across Bare Mtn. Fault

Stop 1 - Meet at Steve's Pass.

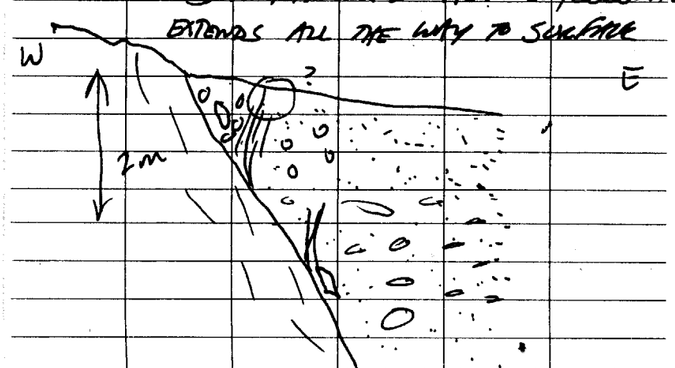
Stop 2 - Trench BMT-2. Stop led by Larry Anderson.

- Says that evidence suggests 1 late Quaternary slip event, prob. not Holocene
- This trench was originally dug as mineral exploration pit. Merith Rehes originally described this trench.
- Carbonate pendants on clasts → carbonate soil
- No dates yet, but samples collected for U-series analysis.
- Merith Rehes concluded that Holocene slip discontinuous along Bare Mtn. Fault.

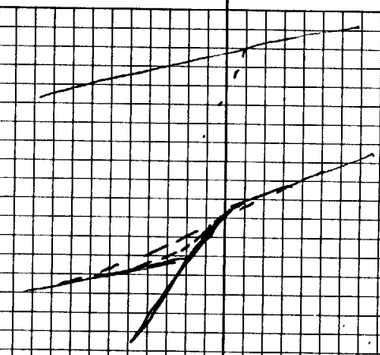
70 5 May 1994



- JOHN BELL ARGUED ADAMENTLY LAST YEAR THAT ZONE OF ORIENTED CLASTS AND FRACTURING OF ALLUVIUM/COLLUVIUM EXTENDS ALL THE WAY TO SURFACE



71



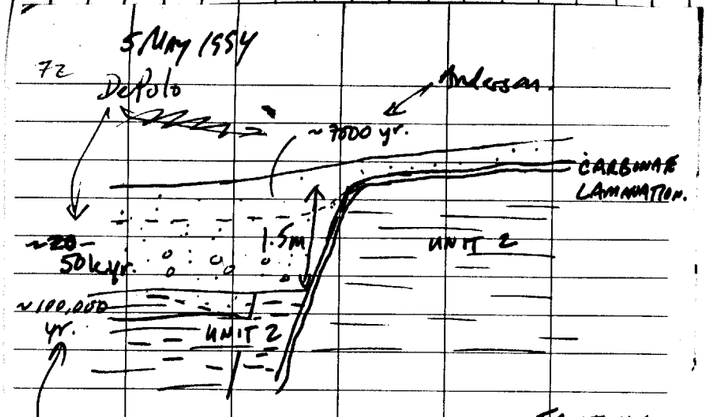
STOP 3 - BMT-1. TRENCH ACROSS BARE MTN. FAULT AT MOUTH OF TARANTULA CANYON. STOP LED BY LARRY ANDERSON.

- NO ABSOLUTE AGES IN TRENCH
- ARTIFACTS IN UPPER HORIZON GIVE MIN. AGE OF 7000 YRS.
- ~~NO~~ BASED ON SOIL - MAY 10-12 KG.

UNIT 4

→ NOT OFFSET BY FAULT.

72 5 May 1994



- INTERPRET ONE UNIT 2 ~~PRO~~ FAULTING EVENT
- CRAIG DEPOLO SUGGESTS 1.5m SLIP MAY HAVE OCCURRED SINCE B/W 20 AND 7 Kyrs. IN AT LEAST 2 AND MAYBE 3 EVENTS.
- 7000 YRS BASED ON ARCHEOLOGY.

5 May 1994 73

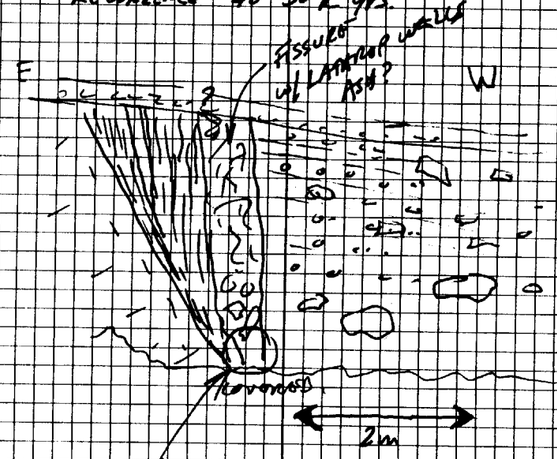
STOP 4 - SOLITARIO CANYON FAULT (TB TRENCH)

(Alan Ramelli)

100 to 200,000 yrs - 4 events - 2 m displacement

→ .01 mm/yr

RECURRENCE 40-50 K yrs.



LOOSE BASALTIC ASH.

→ PHOTOGRAPHS.

74 5 May 1994.

STOP 5 - SOLITARIO CANYON FAULT TRENCH # SCF-T3.

(Alan Ramelli)

- SIMILAR COMPONENTS AND SEQUENCE TO WHAT WAS SEEN IN TRENCH D.
- FISSURES IN TRENCH HAVE QUITE A BIT OF BASALTIC ASH.

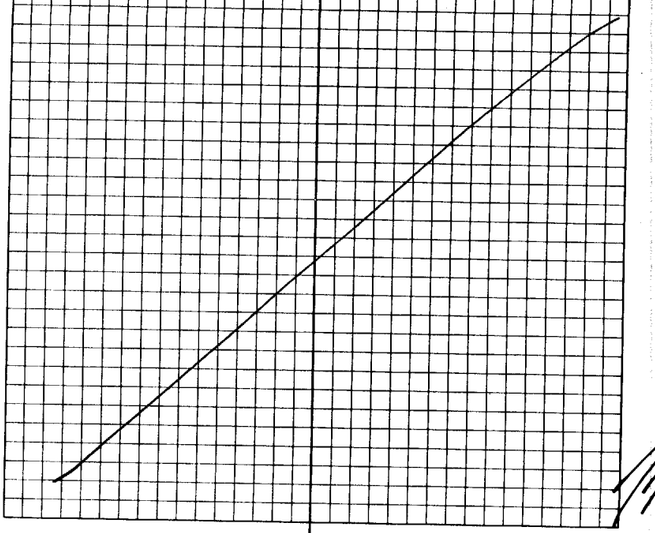
WALK F/M SCF-T3 TO SCF-T1A

- CHUCK HARRINGTON (LOS ALAMOS) DISCUSSED MAPPING SCARP OF SCF AND COSMOGENIC C14 DATING EFF
  - MOST DATES @ 20K YRS AND ONE DATE AT 4K YRS

5 MAY 1994 75

TRENCH SCF-T1A -

- RECENTLY DOC'D, A.R. LARSEN
- INTERESTING STRATIGRAPHIC CHANNELS IN NON WELDED TUFF.



76

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8/14/94 77

SAN FRANCISCO VOLCANIC FIELD, ARIZONA

D. FERRILL & ALAN MORRIS.

- FLEW VIA PHOENIX, AZ, 8/14/94
- DROVE TO FLAGSTAFF (137 mi.) ON 8/14/94
- MET CHRIS CONDIT @ U.S.G.S. OFFICE IN FLAGSTAFF @ 8:30 AM, 8/15/94
  - DISCUSSED HISTORY OF WORK AND LOOKED @ MAPS.
- LEFT FOR FIELD @ ~10:30 AM.
- DROVE N. FROM FLAGSTAFF on (89) TO DIRT ROAD HEADED WEST @ ~ 2 mi. N. OF HART'S TRADING POST.
- DROVE WEST, PASSED N. OF SP CONE, CROSSING SP FLOW @ S. END OF SP FLOW.

78 8/15/94

- CONTINUED DRIVING WEST TO CEDAR RANCH FAULT AND HEADED N. AT TUB RANCH, DRIVING PARALLEL TO ℄ (ON DOWNTHROWN SIDE) CEDAR RANCH FAULT.

- PROCEEDED N., MAKING SEVERAL PHOTO STOPS.

- AN IMPORTANT OBSERVATION ALONG THE CEDAR RANCH FAULT IS THAT THE Qmb FLOW (1.04 ± 0.04 MY) APPEARS TO DRAPE THE FAULT (LINE?) SCARP OF THE KAIBAB LIMESTONE.
  → THIS IS CONTRAST TO MY INTERPRETATION, FROM AIR PHOTOS, THAT THE CEDAR RANCH FAULT CUTS THE Qmb FLOW.

6609

SUGGESTS TIMING OF LAST MAJOR MOVEMENT ON CEDAR RANCH FAULT N/W 1.38 AND 1.04 MY.

- NEAR INTERSECTION OF CEDAR RANCH & MESA BUTTE FAULTS, Qmb FLOW (6609) (DATED TO NE @ 1.38 ± 0.16 MY) IS DOWNDROPPED IN GRABEN, DT TO MESA BUTTE/CEDAR RANCH FAULT SYSTEM.

8/15/94 79

MESA BUTTE CINDER CONE (CONT'D)

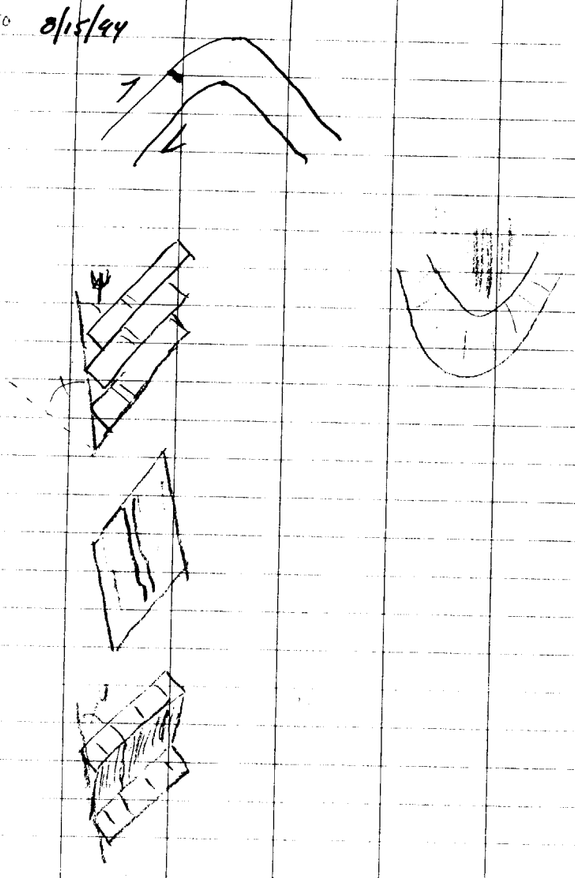
Y 054/37NW ← IRREGULAR SPATTER SURFACE ON BE SIDE OF BREACH ON NE END OF CONE. SEEMS TO BE IN PLACE. BUT STILL QUITE SUSPECT.

Y 042/48NW

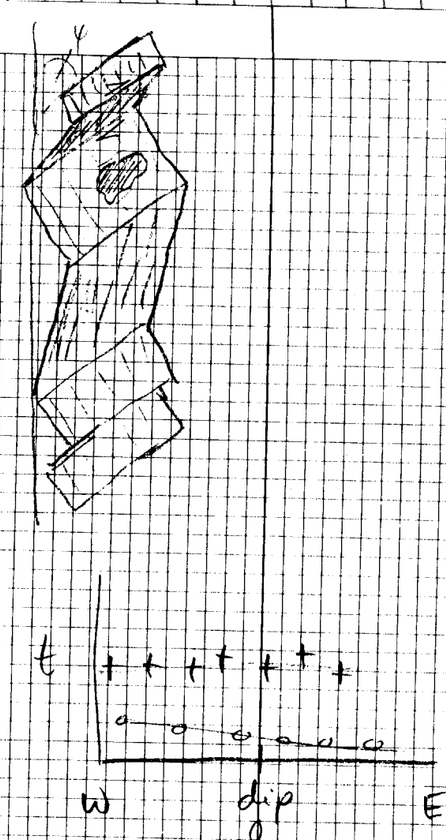
→ UNCERTAIN RELATIONSHIP OF CONSTRUCTIONAL SPATTER TO SLOPE ON "BREACHED" (?) NE END OF M.B. CINDER CONE

- SPATTER WALL IN CENTER OF MB CINDER CONE DOES NOT APPEAR TO BE CUT BY FAULT.
- SPATTER WALL SAMPLED, FOR CHEMICAL COMPOSITION AND AGE DATING, AT EROSIONAL NOTCH @ TOP OF SPATTER WALL (C. CONDIT).
- NO TOTALLY CONVINCING EVIDENCE FOR OR AGAINST FAULTING OF MESA BUTTE CONE.
- NEED TO INVESTIGATE NEXT VENT TO NE (V6604) FOR EVIDENCE FOR OR AGAINST FAULTING.

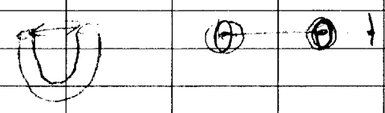
80 8/15/94



8/15/94



82 8/15/94



16 AUGUST 1994

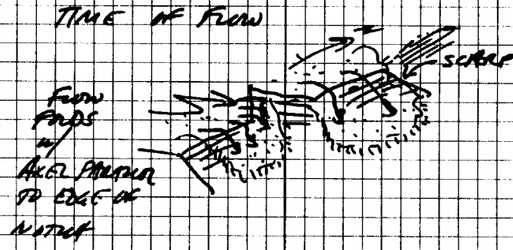
- DROVE IN TO CEDAR RANCH FAULT VIA SAME ROUTE AS YESTERDAY

STOP 1

- PARKED ALONG ROAD ADJACENT TO SOUTHERN EXPOSURE OF Pka/Pkb AND ~~[illegible]~~ T26N R6E SECTION 15, SOUTH CENTER
- WALKED NORTH ALONG FAULT LINE SCARP, STUDYING RELATIONSHIPS BETWEEN Pka, Pkb, and 6609 Qmb. COLLECTED STRIKES AND DIPS WHICH WERE RECORDED BY ALAN MORRIS.
- TOOK MANY PHOTOGRAPHS DOCUMENTING FLOW NEAR EDGE OF FAULT (LINE?) SCARP.
- FLOW FOLDS ALONG MARGIN OF SMALL EXPOSURE (S. SIDE) OF Pka/Pkb.

8/16/94 83

INDICATE THAT EROSIONAL NOTCH THROUGH SCARP WAS PRESENT @ TIME OF FLOW



SAMPLED FOR DATE @ APPROXIMATE SITE OF 0.83 ± .04 MY DATE.

STOP 2. T26N R6E SEC. 15

- PARKED AT CENTER OF SECTION 15.
- WALKED N. ALONG SCARP IN Pk CARBONATES.
- GOOD EXAMPLE OF Qmb FLOW OVER EDGE OF SCARP AT N. END OF ~½ mi LONG CONTINUOUS EXPOSURE OF Pk.
- Qmbt FLOW HAS EASTERN TERMINATION AT N. END OF CARBONATE EXPOSURE.

84 8/16/94

- SOUTHERN Qmbt EXPOSED FLOW (SEC. 15) IS MAPPED TO BE IN CONTACT W/ Pk, HOWEVER, WE SAW NO EVIDENCE OF THIS. Qmbt APPEARS TO OVERLY Qmb.
- Qmbt IS DESCRIBED AS TUFF. THE SOUTHERN FLOW HAS A WELL DEVELOPED FRACTURE CLEAVAGE (~1cm SPACING) WHICH IS NEARLY CONTORTED. THIS COULD BE A WELDING FOLIATION. WOULD BE INTERESTING TO GET CHRIS CONDITS OPINION OF THIS UNIT AND THE FABRIC THERIN.
- NORTHERN Qmbt FLOW AT SOUTHERN PART OF BOUNDARY BETWEEN SEC. 9 & SEC. 10 IS A MORE CONTAINING TUFF (NON WELDED) WITH SMALL (GENERALLY < 3cm), RELATIVELY EQUANT XENOLITHS OF DOLOMITE AND SANDSTONE (?).

8/16/94 85

- STRUCTURAL AND FLOW RELATIONSHIPS IN AREA ON IMMEDIATE SE SIDE OF MESA BOTTE CONE APPEAR TO BE RELATIVELY COMPLEX. NORTHERNMOST RIDGE (V. SMALL RIDGE) SE OF MESA BOTTE CONE MAY BE SMALL FLOW. BROKEN UP VESSICULAR BASALT HAS APPEARANCE OF FLOW SURFACE.
- NW-SE TRENDING ESCARPMENT OF BASALT THAT IS ~2/3 km LONG, PARALLELS NW END OF CEDAR RANCH FAULT, AND IS VISIBLE ON AERIAL PHOTOS LOOKS LIKE IT MAY BE A FAULT DOWN ON EAST SIDE.

→ WALKED E-NE ACROSS VALLEY AND ACROSS Qmb RIDGE TO COLLECT STRIKES AND DIPS. TOPOGRAPHIC EXPRESSION OF 2 FAULTS MAPPED IN Pka IS OBSERVABLE ON SURFACE, HOWEVER FAULT ZONES NOT ACTUALLY SEEN.

→ RETURNED TO CAR AND HEADED FOR FLAGSTAFF.

86 8/17/94

17 AUGUST 1994

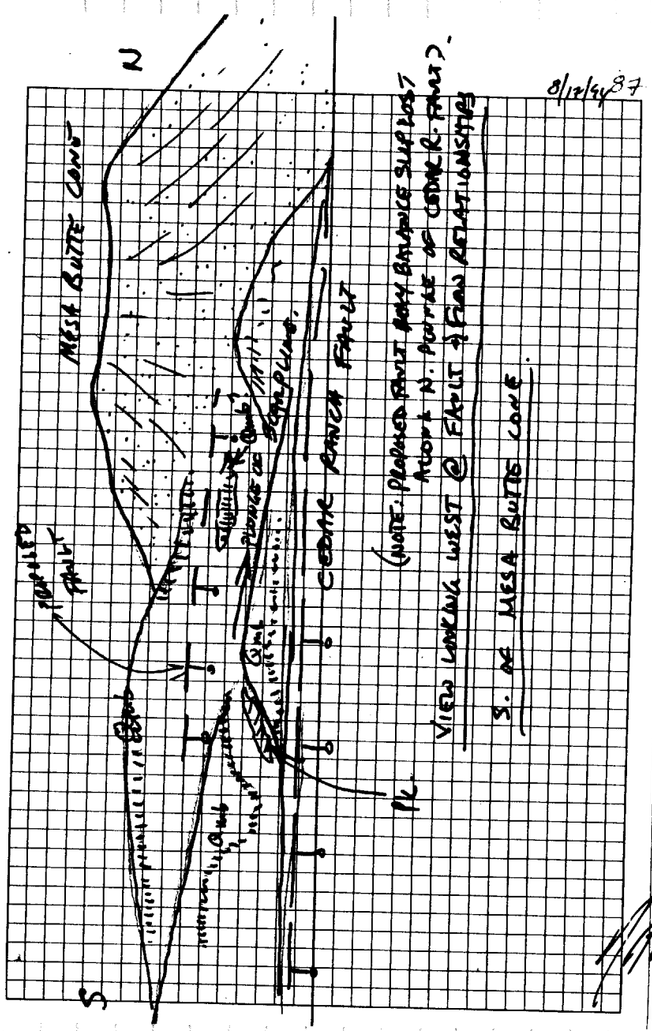
DRIVE FROM FLAGSTAFF TO AREA OF MESA BUTTE CINDER CONE VIA SAME ROUTE AS LAST 2 DAYS.

STOP 1. PHOTO STOP @ BASE OF SP CONE ON S. END OF SP FLOW.

- SHOT NUMEROUS PHOTOS LOOKING;
- ALONG SP FLOW; TOWARDS ALGO. - "VULVA CONE"
- MESA BUTTE CONE/CEDAR RANCH FAULT

STOP 2. PHOTO STOP ADJACENT TO INTERSECTION OF CEDAR RANCH FAULT AND MESA BUTTE CONE.

8/17/94 87



88 8/17/94

- DRIVE NE FROM MESA BUTTE CONE ALONG EAST FLANK OF ADDITIONAL HILL MONOCLINE, NEAR CONTACT W/ 6609 Qmb. COLLECTED STRIKES AND DIPS ACROSS MONOCLINE (ADDITIONAL HILL, INCLUDING MOSTLY GENTLE EASTWARD DIPS, NE STRIKES. HOWEVER, NW DIP OF SEVERAL DEGREES MEASURED AT NW EDGE MONOCLINE, NEAREST MESA BUTTE FAULT. COLLECTED STRIKES & DIPS FROM NW SIDE OF FAULT TO EDGE OF ESCARPMENT. ALAN MORRIS CATALOGUED ORIENTATIONS IN HIS NOTEBOOK.

- ATE LUNCH UNDER JUNIPER ALONG ROAD DUE EAST OF VENT 6604 CINDER CONE.

- DROVE UP ROAD B/W MESA BUTTE CONE AND VENT 6604 CONE AND PROCEEDED SW ALONG POWERLINE (& PIPELINE)

8/17/94 89

ROAD, COLLECTING ORIENTATIONS OF BEDDING IN PK.

- RETURNED TO PK VENT 6604 CONE AND PARKED AT JUNCTURE B/W CONE AND FLOW (Qmb 6604) ON N. SIDE OF CONE.

- ASCENDED NW FLANK OF V 6604 CONE AND INTO SPLATTER CARAPACE. SPLATTER CARAPACE VISIBLE ON FACES ON EITHER SIDE OF CENTRAL VALLEY OF CONE, INDICATING THAT VALLEY ALONG FAULT THROUGH CENTER OF CONE WAS PRIMARY CONSTRUCTIONAL SHAPE RATHER THAN PRODUCT OF SUBSEQUENT FAULTING AND EROSION. TOOK NUMEROUS PHOTOS HERE.
- WALKED N. ALONG Qmb 6604 FLOW TO SCARP-NORMAL CANYON THAT CUTS INTO PK AND Qmb. NORMAL AND REVERSE FAULTS VISIBLE ON N. CANYON WALL (IN CARBONATES BUT APPARENTLY NOT CUTTING 6604 Qmb FLOW.

90 8/17/94

- COLLECTED SAMPLE OF QMB 6604 FOR AGE DATING AND CHEMICAL ANALYSIS.

→ DROVE BACK OUT TO (89) AND FOLLOWED MESA BUTTE FAULT/MONOCLINE N. TO (64) AND TOOK 64 W & N. ALONG KAIBAB MONOCLINE AND N INTO GRAND CANYON NAT. PK.

- STOPPED @ DESERT VIEW AND TOOK NUMEROUS PHOTO'S OF CANYON. EXCELLENT ELECTRICAL STORM ACROSS CANYON.

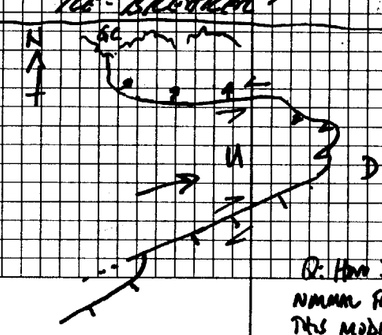
- FOLLOWED (64) ALONG CANYON TO GRANDVIEW POINT. TOOK PHOTOS OF CANYON INCLUDING INTERSECTION OF KAIBAB MONOCLINE AND CANYON, EAST OF POINT. SUNSET

- NOTES/OBSERVATIONS REGARDING KAIBAB MONOCLINE.
  - MONOCLINE HAS MAXIMUM RELIEF

8/17/94 91

@ NW "BLIN" OF MONOCLINE.
- AT BOW, DIP GOES FROM ~HORIZONTAL AT TOP TO VERTICAL OR SLIGHTLY OVERTURNED, THEN ABRUPTLY TO HORIZONTAL AGAIN AT BASE OF SLOPE. THIS IS STRONGLY INDICATIVE OF COMPRESSIONAL FAULTING & ATTENDANT SHORTENING RATHER THAN NORMAL FAULTING

- THIS GEOMETRY ALONG W/ OBSERVATIONS ALONG MESA BUTTE SYSTEM SUGGESTIVE OF "ICE-BREAKER MODEL." MESA BUTTE FAULT MAY BE TRANSTENSIONAL FAULT ALONG STARBOARD SIDE OF "ICE-BREAKER"



Q: HOW DO SMALLER NORMAL FAULTS RELATE TO THIS MODEL

92 8/17/94 / 8/18/94

- DROVE ON TO SUPPER @ GRAND CANYON VILLAGE. DROVE BACK TO FLAGSTAFF AND ARRIVED @ ~ MIDNIGHT.

8/18/94 (THURSDAY)

→ DROVE TO VICINITY OF MESA BUTTE CONE VIA SAME ROUTE AS PREVIOUS DAYS

- TOOK PHOTOS OF BASALT FLOWS COVERING CARBONATES ALONG EDGE OF CEDAR RANCH FAULT LINE SCARP.

- DROVE TO NEAR TO SADDLE @ S. END OF VENTS 6604 AND TOOK PHOTOS OF SPLATTER CRAPACE ON V6604 CONE.

- INVESTIGATING QMBF (FISSURE ERUPTION) @ BASE OF FAULT (LINE?) SCARP IMMEDIATELY N. OF V6604 CONE

8/18/94 93

- FISSURE ERUPTION APPARENTLY OCCURRED (DISCONTINUOUSLY?) FOR 2 MILES NE, EXACTLY ALONG INTERPRETED SURFACE TRACE OF FAULT. THERE DOESN'T SEEM TO BE ANY ROOM FOR THE ASCENDING MAGMA TO HAVE BROKEN STRAIGHT FOR THE SURFACE, EVENT W/I 300M OF THE SURFACE. BUT, THIS IS OF COURSE STRONGLY DEPENDENT OF FAULT GEOMETRY, WHICH WE DO NOT YET KNOW.

- QMBF HAS MASSIVE UNIT AT BASE OF EXPOSURE, OVERLAIN BY MA VESSICULAR BASALT, MASSIVE BASALT SAMPLED FOR AGE DATE.

→ HEADED SE ACROSS VALLEY TO APPARENTLY UPTHROWN QMB 6609 (SE 1/4 SEC 3 T26N R6E & NE 1/4 SEC. 10).
- STRONG FABRIC PARALLELING TREND OF OUTCROP (INTERPRETED FAULT) AND DIPPING STEEPLY WESTWARD.
- FRAGMENTAL VESICULAR LAYERS INTERLAYERED

94 8/18/94

WITH MASSIVE UNITS W/ FABRIC. TEXTURE AND OUTCROP FABRIC SUGGESTIVE OF FISSURE DEPOSITS.

• PLANAR FABRIC APPARENTLY ALLOWS WATER TO REACH FAR INTO ROCK. BROWN STAINING IN ROCK ALONG FABRIC. WERE UNABLE TO COLLECT SUITABLE SAMPLE FOR DATING, HOWEVER DID COLLECT SMALL SAMPLES FOR CHEMICAL ANALYSES.

→ PROCEEDED NORTHEASTWARD ALONG PIPELINE TO SITE OF 1.38 ± 0.16 DATE TO ATTEMPT TO COLLECT SAMPLES FOR DATING & CHEMICAL ANALYSES.

→ COLLECTED ENOUGH GOOD QUALITY SAMPLE FOR CHEMICAL ANALYSIS, AND POSSIBLY ENOUGH FOR AN AR/AR DATE.

8/18/94. 95

• DROVE ~½ MI SOUTHWESTWARD TO INTERSECTION WITH AND HEADED S-SE THROUGH WESTERN PART OF SEC. 2 (T26N R6E) AND STOPPED NEAR BORDER B/W SEC. 2 AND SEC. 11.
- COLLECTED BEDDING ORIENTATIONS FROM PKA, WEST OF ROAD.
- COLLECTED SAMPLES OF 6609 Qmb FOR CHEMICAL ANALYSIS AND AR/AR DATING. THIS SAMPLE IS CLEARLY SAME UNIT THAT WE ATTEMPTED TO SAMPLE (T26N, R6E, SEC 10) EARLIER.

→ CONTINUED S-SE ALONG ROAD COLLECTING BEDDING ORIENTATIONS FROM PKA.
- COLLECTED 6609 Qmb SAMPLE FOR AGE DATING AND CHEM. ANALYSES FROM WORKLINE OUTCROP AT BORDER B/W SEC 13 & SEC 24.

96 8/19/94

8/19/94 -

6:30 A.M.
OVERFLIGHT OF SAN FRANCISCO VOLCANIC FIELD WITH CHRIS CONDIT IN HIS CESNA 170.

- LATER MORNING - MET W/ CHRIS CONDIT AT U.S.G.S. OFFICE. MET PAUL DELANEY ABOUT PROJECT ON MEGA BUTTE FAULT.
- GAVE US REFERENCES ON KAIBAB MONOCLINE BY ZEV RECHES.

- TALKED W/ CHRIS CONDIT ABOUT DATING SAMPLES AND CHEMICAL ANALYSES.

CHEMISTRY: J. MICHAEL RHODES @ U. MASS. ONE OF BEST LABS IN WORLD.
DATING: BILL MACINTOSH @ NEW MEXICO SOCORRO
→ TALKED TO TALK TO BRITT ABOUT THIS.

10/5/94 97

5 OCTOBER 1994

VOLCANISM PEER REVIEW
FIELD TRIP

PARTICIPANTS:

CNWRA: CHUCK CONNOR
BRITT HILL
GERRY STIREWALT
DAVID FERRILL

NRC: BILL OTT
LINDA KOVACH
STEVE MCDUFFIE

PEERS: ALEXANDER MCBIRNEY
GEORGE WALKER
PETER LIPMAN
STEVE SELF
PAUL DELANEY

98 STOP 1 10/5/94

LATHROP WELLS CINDER CONE

DISCUSSIONS

- CRATER SLOPES MUCH LOWER THAN ANGLE OF REPOSE
- EOLIAN INFLATION (DUST BENEATH CINDERS) VERY WELL DEVELOPED
- NO EVIDENCE OF FRACTURING IN CRATER.
- WALKER → BIMODALITY OF VESICULARITY
  - BIG BOMBS – LESS VESICULAR
    - POND DEGASSED IN CONE BEFORE BEING THROWN UP.
  - CINDERS – MORE VESICULAR
    - LESS RESIDENCE TIME DEGASSING
  - → CHARACTERISTICS OF STRUMBOLIAN ERUPTIONS.
- FRANK PERRY & CO. HAVE SAID THAT THERE HAVE BEEN 10 ERUPTIVE EVENTS @ LW IN LAST 100 KA, AND THAT

10/5/94 99

NEXT ERUPTION IN YM AREA ~~WILL~~ (IF W/I NEXT 10 K YR) WILL BE AT L.W.

→ THEREFORE, THERE IS NO RISK OF ERUPTION @ YM IN NEXT 10 KYRS.

- NE SIDE OF LW CONE HAS NUMEROUS REDDISH MOUNDS THAT ARE MAPPED AS SCORIA MOUNDS MARKING VENT ZONES. THIS GROUP SEEMS TO BE IN AGREEMENT THAT THESE ARE INSTEAD RAFTED BLOCKS OF CINDER CONE THAT SLUMPED, LIKELY IN A SINGLE EVENT (THERE IS NOT PARTICULARLY GOOD EVIDENCE THAT THERE ARE NUMEROUS ERUPTIONS MARKED BY SCORIA MOUNDS @ VENTS).

*

- WALKER, SELF, LIPMAN, etc. SUGGEST SAMPLING ASH

5 OCT. '94.

FALL DEPOSITS AND PERFORMING TEXTURAL ANALYSIS TO EVALUATE ERUPTION DYNAMICS (& ENERGETICS).

→ SURPRISING THAT THIS HASN'T BEEN DONE BEFORE! IT SEEMS LIKE THE OBVIOUS THING TO DO.

- ~~NORTHWEST~~ SIDE OF LW CONE. VERY BLACK ASH LAYER. ~~THIS~~ WALKER POINTED OUT AT LAST STOPS THAT ASH VERY RED WHERE DEPOSITED ON TOP OF HOT BASALT FLOW. WOULD BE BLACK WHERE DEPOSITED ON COOL SURFACE. OBSERVATIONS HERE PERFECTLY CONSISTENT WITH THIS. ASH ON TOP OF BASALT VERY RED (S. SIDE OF CONE, AND ASH ON ~~WEST~~ SIDE (NOT ON TOP OF FLOW) IS BLACK (!) SUGGESTING ONE EVENT.

5 OCT '94 107

- NORTHWEST SIDE OF CONE. FINE GRAINED DEPOSITS PREVIOUSLY INTERPRETED TO HAVE HIGH-ENERGY PHREATOMAGMATIC DEPOSITS. NOTED BY OUR GROUP (WALKER, SELF, LIPMAN) THAT ABUNDANT SAND SIZED MATERIAL (V. WELL SORTED) WITH ABUNDANT QUARTZ SAND. BEDDING DIPS TOWARD SE, IN DIRECTION OF L.W. CONE. MAY BE (LIKELY TO BE) EOLIAN REWORKED ASH AND QTZOSE SAND. SMALL PUMICE FRAGMENTS COMMON INTERLAYERED W/ SAND SIZED ~~FR~~ LAMINAE.
- "SCORIA MOUNDS" (LAST STOP OF DAY). CONCENSUS STILL SEEMS TO BE THAT THESE ARE LIKELY TO BE RAFTED BLOCKS, FROM THAT SIDE OF THE CONE.

→ SUPPER @ EXCHANGE CLUB, SPENT NIGHT @ BURRO INN

102 6 Oct. '94.

DAY 2 OF VOLCANISM PEER REVIEW

STOP 1 – STEVE'S PASS
→ OVERVIEW OF REGIONAL GEOLOGY.
→ I GAVE AN OVERVIEW OF STRUCTURAL SETTING.

STOP 2 – LITTLE CONE.

Walker → RATE OF INCREASE OF VESICLE SIZE W/ CLASTS INDICATIVE OF VISCOSITY.

(margin: HIGHER VISC.? →)
• HERE, DOUBLING OF VESICLE SIZE EVERY 2 CM OR SO.

(margin: LOWER VISCOSITY →)
• LATHROP WELLS, RATE OF INCREASE OF VESICLE SIZE WAS LESS.

STOP 3 – TRENCH 8 – SOLITARIO CANYON FAULT

6 Oct. '94. 103

GEORGE WALKER SUGGESTS

→ CENTRAL ITALY – N & S OF ROME & IN ROME

NINTH C. → 2800 YR! OLD TUNNELS IN ASH FLOW TUFFS. STABLE IN SEISMICALLY ACTIVE AREA (M 7+ EQ 20 YRS AGO). DRY!

(margin: ROME ASSOC. W/ ETRUSCAN CIVIL. (COMMON) QUAT.; SMALLER THAN REPOSITORY SCALE.)

• EARLY CHRISTIANS → CATACOMBS (~30 A.D.)

PETER LIPMAN –

→ CAPPADOCIA – ANATOLIA TURKEY

NAT. GEO.: CAVES DUG OUT & LIVED IN EXTENSIVELY. ASH FLOW TUFFS (QUAT) 400–1200 A.D.

(margin: ALSO GRANT HEIKEN WROTE POPULAR ARTICLE)

→ ARMENIA ALSO HAS TUNNELS.

104 6 Oct. '94.

ETRUSCANS –

* BEAUTIFUL WALL PAINTINGS WELL PRESERVED.
* CAREFULLY HID TREASURES IN TUNNELS. STILL OCCASIONALLY FIND TREASURES.

RE ~~SOLITARIO CANYON~~ "BASALTIC ASH" IN FISSURE IN HW OF SOLITARIO CANYON FAULT.

PETER LIPMAN SUGGESTED THAT THE INTERPRETED ASH MAY INSTEAD BE WEATHERED BLACK VITROPHYRE. LATER SMALL BLOCKS OF VITROPHYRE WERE [illegible] ALONG FAULT SURFACE – WEATHERING TO FORM QUITE SIMILAR LOOKING MATERIAL

6 Oct. '94 105

PLIOCENE (4 MY) BASALTS

PROBABLE VERTICAL TUBE IN DIKE – PROBABLY FED FISSURE ERUPTION.

• DIKES CUT ~~[illegible]~~ CINDERS AND PROBABLY FED LAVA TO SURFACE BASALT FLOWS
• FEEDER DIKES – ONE EXAMPLE WHERE DIKE W/ FLOW FABRIC ~~[illegible]~~ CUTS CINDERS AND CONNECTS W/ FLOW ABOVE.

106 6 Oct. '94.

NOTES MADE IN EVENING @ FURNACE CREEK STEAKHOUSE.

▷ NEED TO CONTACT PAUL DELANEY TO REMIND HIM TO SEND MC REPRINTS OF HIS ARTICLES ON DIKE INTRUSION.

▷ PETER LIPMAN SUGGESTED TO KEEP IN MIND WHEN DEVELOPING TECTONIC MODELS THAT YM, CF, BM ARE VERY CLOSE TO TIMBER MTN. CALDERA.

LIPMAN APPARENTLY LOOKED HARD (BACK IN 1960'S?) FOR EVIDENCE OF STRIKE SLIP MOVEMENT IN YUCCA WASH FAULT & OTHERS. SEEMS TO STILL THINK STRIKE SLIP MOTION OCCURRED ON THOSE FAULTS (NO STRONG EVIDENCE.

6 Oct. 94 107

LIPMAN MENTIONED SCISSORING ON SOLITARIO CANYON FAULT AS EVIDENCE FOR SS. THIS IS GENERALLY NOT TOO CONVINCING OF AN ARGUMENT.

PLIPMAN ⇒ MENTIONED HAVING SEEN LOTS OF LOW ANGLE FAULT(S) IN CALICO HILLS. ~~FEELS THAT FATEL~~ SEEMS TO FEEL THAT FRIZZELL & SHUTTERS JUST CHOSE TO IGNORE THE EVIDENCE.

NOTE THE THERMAL EVENT ASSOCIATED W/ THE TIMBER MTN. CALDERA MAY HAVE AFFECTED DEFORMATION MECHANISMS ALONG DETACHMENT FAULTS AT N. END OF BM AND IN CALICO HILLS.

108 6 Oct '94

NOTES FROM BARE MTN MAP.
MONSEN, CARR, REHEIS, & ORKILD.
1992

• OAU - Antelope Valley Fm of Pogonip Group supposed to contain c.g. LS.

OAU mapped in HW of detachment fault N. of Tarantula Canyon.

(→ On map. FIND FRACTURED carbonate that was visible on DOE aerial photos near (N of?) Tarantula Canyon)

• → Can also potentially sample OAU adjacent to other faults to South of Tarantula Canyon.

6 Oct '94 109

→ Measure strike and dip of fractures and faults.

→ Measure slip lineations on faults.

→ Measure orientation of bdg.

→ Sample for fission track dating

→ Sample for Paleomag.

→ Sample c.g. carbonate rx. adjacent to and away from faults.

→ Sample other rx at and away from faults.

110 7 Oct. 1994

TECTONICS RESEARCH
FIELD WORK AT
BARE MTN., NEVADA

DAY 1

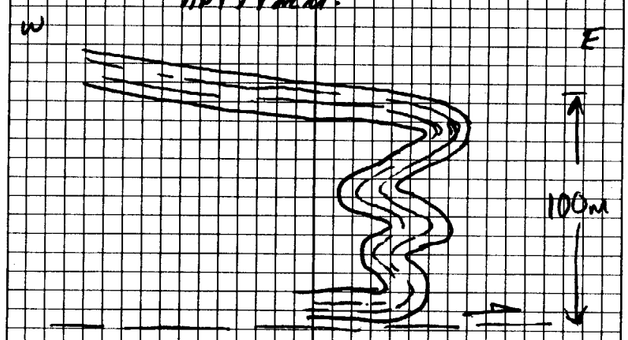
- LEFT BEATTY, NV AND DROVE EAST UP FLUORSPAR CANYON.
- STOPPED TO STUDY CRETACEOUS SILL THAT SURROUNDED BY CAMBRIAN CARBONATES. (MOSTLY DOLOMITE).
- STUDIED FAULTS FABRIC IN DOLOMITE AND LIMESTONE IN FOOTWALL OF DETACHMENT FAULT.
  - STRONG PENETRATIVE GRAIN SCALE FOLIATION, CUT BY N-S SUBVERTICAL EXTENSION VEINS.
  - LIMESTONE AND DOLOMITE PRESENT.

7 Oct. '94 111

- TUFF IN HW HAS BRITTLE FABRIC - DEFORMATION INTENSITY V. LOW COMPARED W/ CARBONATED IN FOOTWALL.

→ GOOD PLACE TO STUDY FAULT ROCK FABRICS IN FOOTWALL AND HANGINGWALL.

WEST OF SPECIE SPRINGS - RECUMBENT ANTIFORM.



FOLD IN On (Ordovician Ninemile) IN TARANTULA CANYON

112 7 Oct. '94

DEVONIAN TARANTULA FORMATION BETWEEN SPECIE SPRING AND BARE MTN FAULT.

- BOULDER CONGLOMERATE. CARBONATE BLOCKS IN F.G. CARBONATE MATRIX.
- GOOD PLACE TO DO CONGLOMERATE TEST FOR REL. TIMING OF MAGNETIZATION.
- INTERNAL DEFORMATION INTENSITY MUCH LESS THAN CARBONATES SEEN EARLIER.

↳ THIS UNIT MAY BE RELATED TO ANTLER UPLIFT.
→ MAY HAVE EXPERIENCED ONE FEWER DEFORMATION EVENTS THAN OLDER CARBONATES.

7 Oct. '94 113

MIOCENE DIKE NEAR BM FAULT @ 6T END TARANTULA CANYON.

→ BEST EXPOSED EXAMPLE ALREADY SAMPLED. PROBABLY BY SCHWEICKERT'S STUDENT.

→ LET'S SAMPLE UNMAPPED DIKE TO EAST.

114 8 OCTOBER 1994. (SATURDAY)

DAY 2 - TECTONICS FIELD WORK @ BARE MTN., NEVADA.

- GEORGE STIREWALT JOINED GROUP, HE IS PLANNING TO BE WITH US TODAY AND SUNDAY. WILL RETURN TO WASHINGTON, D.C. ON MONDAY.

1ST STOP. CARBONATES SOUTH OF STONE'S PASS.

→ FOLD IN CARBONATES LOOKS LIKE GOOD SAMPLE LOCALITY TO COME BACK TO.

2ND STOP. TUNGSTEN CANYON.

→ COLLECTED HAND SAMPLES FROM OLIGOCENE DIKE EXPOSED IN MINE ENTRANCE ON N SIDE OF CANYON (& RD).

→ WHILE REST OF GROUP SAMPLED, I WANDERED UP RIDGE S. OF CANYON, MEASURED FABRICS

NOTE: COMPASS DECLINATION SET ON 0!

DFBM1
KATHY'S LOCATION 8.2B1

8 Oct. 94 115

TUNGSTEN CANYON - HILLTOP S. OF CANYON

BEDDING
- 075/67S(OT)
- 058/48S(OT)
- 068/51S(OT)
- 068/58S(OT)

CLEAVAGE
- 040/46S
- 054/41S
- 040/50E

DFBM2 - 8.2B2 (Spring)
EAST OF SADDLE, WHICH IS EAST OF HILLTOP

BEDDING
- 077/85S
- 091/85S
- 074/80S

CLEAVAGE
- 046/50E
- 032/54E

JOINTS
- 170/80W
- 000/79W
- 175/87W

→ LUNCH @ THIS STOP.

116

NOTE: DECLINATION NOW SET ON 14.5°.

DFBM3 - (MARKED ON MONSEN et al. BM Geologic Map).
STERLING QUARTZITE

- 070/33N Bdg
- 070/40N Bdg.

DFBM4. - STERLING QUARTZITE
CREST OF RIDGE, JUST IN 50 M FROM UNMAPPED DIORITE DIKE.

- 050/80NW
- 060/84NW

DFBM5 - DIORITE DIKE SAMPLES

DFBM5d1 176/35W (MEASURED, ORIENTED FRACTURE SURFACE. DIORITE DIKE). DIORITE 65 CM FROM NW EDGE OF DIKE

117

DFBM5sq1
STERLING QUARTZITE SAMPLED W/I 20 CM OF CONTACT W/ DIKE. COLLECTED QTZITE SAMPLE ON NW SIDE OF DIKE @ CONTACT.

ORIENTATION OF CONTACT ON NW SIDE OF DIKE.
- 025/69SE

150/32W DFBM5d2
2nd diorite sample. C.G. DIORITE
• 8.4 m F/m NW EDGE OF DIKE; 1.6 m F/m SW EDGE

163/72W DFBM5d3
3rd diorite sample. CG. DIORITE.
• 2.1 m FROM NW EDGE OF DIKE.
MEASURED WIDTH OF DIKE = 10 M.

DFBM5sq2
STERLING QUARTZITE W/I 5 CM OF NW CONTACT W/ DIKE

118 8 Oct. '94

DFBM 5 & 3
SAMPLED CONTACT B/W STERLING QTZITE & DIKE.
INCLUDES F.G. DIORITE @ CONTACT.

DFBM 6 - STERLING QUARTZITE
Y 064/79W BEDDING
Y 062/65W BEDDING.
Y 031/63W CLEAVAGE

→ WHILE STEVE & I SAMPLED HERE - THE REST OF THE GROUP DRILLED CORES OF MAFIC ORBICULAR DIORITE DIKE @ STERLING VALLEY.

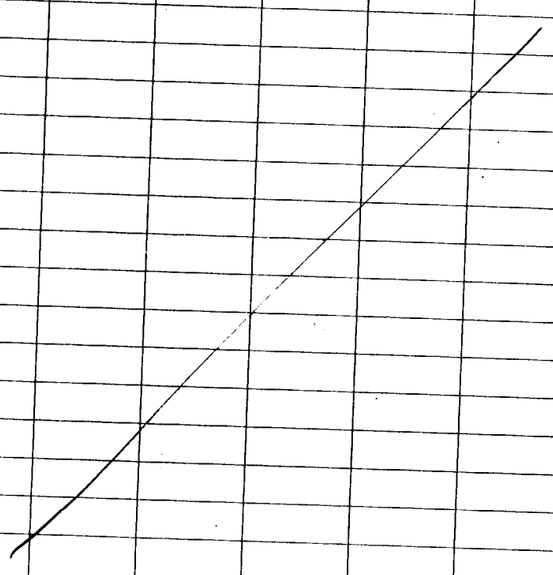
→ JOHN & KLAN HIKED UP TO HAND SAMPLE FURNACE CK AREA & BACK.

→ RETURNED TO BUREAU TOWN. QUICKLY CHANGED & DROVE TO ZABRISKIE PT. AND TO FURNACE CK. RANCH FOR SUPPER.

8 October 1995.

2. SAMPLE TESTING TUFFS FROM NEARLY CONFORMABLE SECTIONS E/W FAULT BLOCKS - RESTORED TO NORTH END OF BARE HILL.

→ OLDER UNITS MAY RECORD PROGRESSIVELY MORE EXTENSION THAN YOUNGER TUFFS UNITS.



120 8 Oct. '94

DAY 3 OF TECTONICS FIELD RESEARCH

STOP 1. WEST END OF FURNACE CANYON - COLLECTING CRETACEOUS DIKE AND SURROUNDING DIORITE FOR PMAG.

COLLECTING CALCANAIRE APPALACHIAN FAULT ZONE & TUFF IN HANGINGWALL TO STUDY DEFORMATIONAL MECHANISMS

DFBM 7 & PHOTOS LOOK NORTH ACROSS OF CANYON FROM BOTTOM OF FURNACE CK. FAN.

MEASURE ORIENTATION OF SAMPLED 5 M BELOW DEFORMATIONAL FABRIC.

→ 090/60N MEASURED ON WEATHERED SURFACES. BEDDING ORIENTATIONS

8 Oct. '94. 119

IDEAS FROM THE DAY -

1. TO CONSTRAIN TIMING OF UPLIFT WITH RESPECT TO DIKE INTRUSION (WHEN IS DETERMINED), COMPARE FISSION TRACKS IN QTZITE IMMEDIATELY ADJACENT TO DIKE WITH QTZITE OUTSIDE OF CONTACT ZONE. IF COOLING THROUGH FISSION TRACK CLOSURE T ASSOCIATED WITH INTRUSION, THEN CRYSTALS ADJACENT TO INTRUSION WILL BE ANNEALED AND SHOULD RECORD LATER, YOUNGER T THAN THOSE OUTSIDE CONTACT ZONE.
IF INTRUSION PRECEDED DOMING THROUGH COOLING T, THEN UPLIFT TIMING WILL BE SAME W/O REGARD TO POSITION WITH DIKE.

→ SAMPLED STERLING QUARTZITE @ DFBM 5 TO TRY THIS OUT.

9 Oct. '94 121

DAY 3 OF TECTONICS FIELD RESEARCH

STOP 1. WEST END OF FURNACE CANYON - COLLECTING CRETACEOUS DIKE AND SURROUNDING DIORITE FOR PMAG.

COLLECTING CALCANAIRE APPALACHIAN FAULT ZONE & TUFF IN HANGINGWALL TO STUDY DEFORMATIONAL MECHANISMS

DFBM 7 & PHOTOS LOOK NORTH ACROSS OF CANYON FROM BOTTOM OF FURNACE CK. FAN.

MEASURE ORIENTATION OF SAMPLED 5 M BELOW DEFORMATIONAL FABRIC.

→ 090/60N MEASURED ON WEATHERED SURFACES. BEDDING ORIENTATIONS

122 90ct. 94

DFBM7b - Tr. Middle Mirrow "rhyolite lava" → LOOKS MORE LIKE GLASSY TUFF.

089/45N

089 089/45N MEASURED ON FRACTURE SURFACE.
→ BEDDING ORIENTATION UNKNOWN.
→ SAMPLE FROM 5m ABOVE DETACHMENT FAULT.

→ LITHIC DENSE UNIT IMMEDIATELY ABOVE SAMPLED UNIT WEATHERS TO ANGULAR FRAGMENTS < 1 cm
• EXTREMELY ASCENDANT SUCCESSIVE FRACTURE SURFACES.

DFBM8 - Ttmr

→ Red Rock's Mesa Tuff sampled immediately adjacent to fault surface.

90ct '94 123

055 / 75SE / 18

FAULT ORIENTATION 055/75SE. SLICKENSIDES RAKE 18° SW.

078 / 77SE

ORIENTATION ON FRACTURE SURFACE. (SAMPLE DFBM8)

SAMPLE FROM ~30m ABOVE DETACHMENT SURFACE (ESTIMATED NORMAL TO DETACHMENT SURFACE).

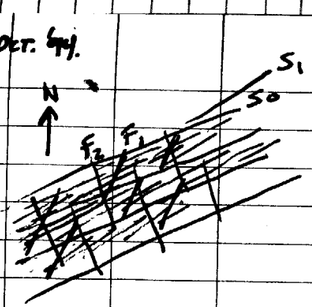
DFBM9 - PARADISE LAKE MBR of Barrow Rock Fm.

S_0 072/90 BEDDING

S_1 069/88NW CLEAVAGE

F_1 029/83E VEINS (CROSS FRACTURES) WITHIN STRATA TO WHICH CLEAVAGE

124 90ct. 94.



S_1 FABRIC APPEARS TO BE DEFINED BY GRAIN SCALE ALIGNMENT FABRIC. SUGGESTS PENETRATIVE DUCTILE DEFORMATION.

DUE TO SURFACE TEXTURE, AND THINNESS OF VEINS, RELATIVE TIMING BETWEEN F_1 AND F_2 VEINS NOT CERTAIN

F_2 177/82W VEINS.

SAMPLE DFBM9

TWO SURFACES ORIENTED

063 / 82SE 062/32SE LAYERING

087 / 40 087/40SE LAYERING

125 90ct.'94

32N / 114

AXIAL SURFACE ORIENTATION OF 4cm 2 FOLDS IN SAMPLE

114/32N — AXIAL SURFACE OF SMALL FOLD IN HAND SAMPLE.

FOLD AXIS 080/03E

→ DEFORMATION IN THIS LOCALITY IS VERY COMPLEX. MIGHT BE WORTH WORKING ON LATER, AFTER STUDYING CROSS-CUTTING RELATIONSHIPS IN THIN SECTION.

DFBM10 - PARADISE LAKE MBR of Barrow Rock Fm.

FINELY LAMINATED WATER-LAID TUFF WITH ABUNDANT LAPILLI (1-3 cm).

BEDDING CLEARLY VISIBLE - OTHER WEATHERING OF POSITIVE RELIEF.

074/68 NW BEDDING

126 9 Oct. '94.

SAMPLES DFBM10 - Intermediate. Lat ~ 40.68°
076/72NW MEASURED ON BEDDING.

028/53SE VEINS - VERY WELL DEVELOPED AND CONSISTENT. SPACING <1cm
032/54SE TO ~5cm.

OTHER FRACTURES-SETS PRESENT BUT SETS MUCH LESS WELL DEVELOPED

DFBM11 - DIORITE DIKE SAMPLED. OTHER. (UNNAMED BY MORRIS et al.)

• THIS IS ANOTHER POTENTIAL PLACE TO TEST FISSION TRACK RESET BY DIKE INTRUSION.

SAMPLE FOR FISSION TRACK ANALYSIS. → Euld. Unit D of Lower Mbr of Paleozoic Wood Canyon

DFBM11a
061/30N ORIENTATION on BEDDING

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101/27N BEDDING
145/70E UPPER DIKE CONTACT.
131/38NE BEDDING.

DFBM11b.
045/60W orientation on BEDDING fracture surface.
↑ UNABLE TO RECOVER THIS SAMPLE.

DFBM11c DIKE SAMPLED ~ 1m below upper edge banding with Quartz Vein

DFBM12
NOTE: ANOTHER DIORITIC DIKE ~ 100m SW OF DFBM11, ALSO, APPEARS TO BE ANOTHER ACROSS GULLY (~ NNW DIRECTION) (CONFIRMED BY VISIT)

DFBM13
DIKE 20 N OF DFBM12 CONFIRMED BY VISIT. (INTRUDES CARBONATE ROCKS). ESTIMATED STRIKE OF DIKE 020-060

128 9 Oct. 94.

DFBM14 - DOLOMITE OF Cpp @ RIDGE CREST. COMPOSITIONAL LAYERING (BDG) QUITE VISIBLE).
60N
080 BEDDING 080/60N ON BOTTOM OF BIG PLANE.
125/50N BEDDING @ SAME OUTCROP.
NOTE: PROBABLE N/S FAULT BETWEEN STATIONS DFBM9 & DFBM14.

DFBM15 - TEMA
STATION 2nd-3rd MOMENT of DFBM8
105/73S
SLICKENSIDES RAKE @ 16° SW.
106/79S
SLICKS RAKE @ 27° SW.

129 10 Oct. 94

DAY 4 OF TECTONICS FIELD WORK @ BALE MTN. NEVADA

SMP1 DFBM16 - Zabriskie Quartzite. (Sample for Fission Tracks).
163/33E
151/35E } Bedding
(NOTE: PHOTOS FROM ROCKS DUE EAST OF SAMPLE)

DFBM17 - Carbonate Grainstone of Ordovician Antelope Valley Formation
→ Sample collected for microstructural analysis. Very fossiliferous of crinoid plates.
163/55NE — Orientation marked on top bedding surface.
086/88S — Striation marked on fracture surface.

DFBM18 - Oav.
PHOTOS LOOKING W, N, & E.

NOTE: LIMESTONE GRAINSTONE SAMPLES HAVE FOSSIL HASH LAYERS THAT RECORD VERY LOW GRAIN-SCALE STRAIN. EXTENSION VEINS IN 1 SET ± ON EACH BED

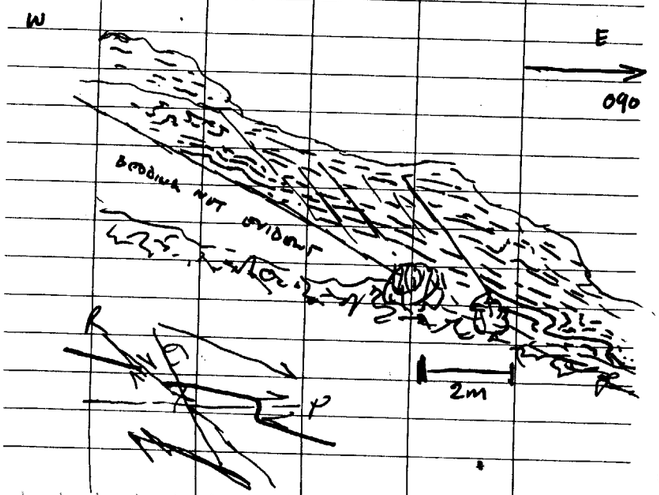
130 10 Oct. 94

DFBM19 - Eureka Quartzite.

SAMPLE COLLECTED FOR FISSION TRACK ANALYSES. 12 PIECES. 4 HAVE CARBONATE (CALCITE) CEMENT AND ARE MARKED "C.C."

X 145/30 N } BEDDING.
to 35N }

DFBM20 - Ogs - Ordovician Ely Springs.
• PHOTOS TAKEN HERE



10/Oct. '94. 131

3 SAMPLES COLLECTED @ DFBM20 FOR PALEOMAGNETIC ANALYSIS (SDM TO EAST OF SHELTERED OUTCROP)

X 145/35E BEDDING.

DFBM20a X 144/30 NE } NOT BEDDING!
DFBM20b X 157/48 NE } all on inclined
DFBM20c X 107/42 E } on bedding

11 Oct. 94

DAY 5 OF TECTONICS FIELD WORK @ BARE MTN, NEVADA

DFBM21 - PHOTOS TAKEN FROM JUST EAST OF PASS, LOOKING WEST TO SIERRA NEVADA (SWAN CAMPED). NORMAL FAULTS VISIBLE IN NORTH WALL OF CARRARA CANYON

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DFBM22 - Oligocene Quartz Latite dike cutting Ebbl + Ebbu.

Ebbu = Upper Part Banded Mountain Member of Barrenga Key Fm.
Ebbl = lower part of Banded Mtn Member of Barrenga Key

Photos taken looking NE @ Normal Faults along E flank of Bare Mtn. and YM Pass + T.M. Canyon in distance.

DIKE 10 M WIDE

dike { DFBM22.1 007/85 } EAST MARGIN OF DIKE
dike { DFBM22.2 014/86 }
dike { DFBM22.3 110/40 } WEST MARGIN OF DIKE
dike { DFBM22.4 240/40 }

Ebbl { DFBM 22.5 010/80 OT = 010/100 } IMMEDIATELY ADJACENT TO WEST DIKE MARGIN.
Ebbl { DFBM 22.6 090/59N } ON BEDDING.

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DFBM23 -

TQl Quartz Latite dike on ridge to N of site DFBM22.

DFBM23.1 276/85
DFBM23.2 073/85
DFBM23.3 123/88

DFBM24 - Ebbu

X 067/87 NW ? } BEDDING
— 083/66 N }
— 083/67 N }

DFBM24.1 236/105
DFBM24.2 242/82
DFBM24.3 096/50
DFBM24.4 350/29E

DFBM 25 - End
— 090/50N BEDDING }
X 138/40N CLEAVAGE }

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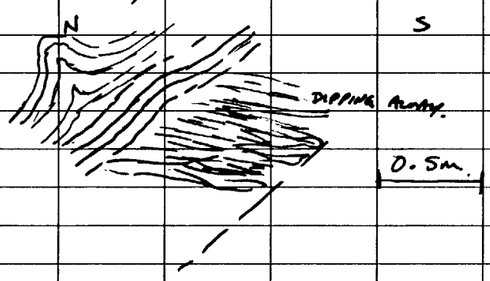

Slightly metamorphosed shale (sounds like walking on glass) which contains graptolites and framboidal (?) pyrite. Neither show significant strain in hand sample. Disharmonic mesoscopic folding is present.

045/50 ← BEARING & plunge of mesoscopic fold axes.

11 Oct. 94 135

DFBM25 - Ebbl

Y 067/60 N BEDDING (MEASUREMENTS FROM
Y 070/50N BEDDING SAMPLES 4 & 3)

DFBM25.1 140/78 } ON FRACTURE SURFACES
DFBM25.2 125/25 }
DFBM25.3 070/140 (UNDERSIDE BEDDING)
DFBM25.4 067/150 (UNDERSIDE BEDDING)

DFBM27

~~DFBM 320/65NW~~ BEDDING
063/45NW

DFBM27.1 248/55
DFBM27.2 103/52
DFBM27.3
DFBM27.4
DFBM27.5 303/37
DFBM27.6 272/30

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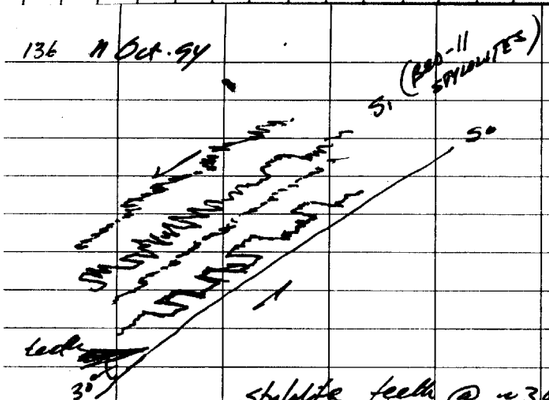

Stylolite teeth @ ~30° to bedding. Geometry indicates (suggests) top to N shear. ~11 baddy dip.
Numerous photos taken

~~NOTE: Similar TOP TOWARDS DOWNDIP~~

NOTE: CLEAVAGE AND MESOSCOPIC FOLD VERGENCE @ STATION DFBM25 SUGGESTED SAME SENSE OF SHEAR = TOP DOWN SHEAR PARALLEL TO BEDDING. ALSO, DFBM2, WHICH WAS USED TO INTERPRET OVERTURNED BEDDING.

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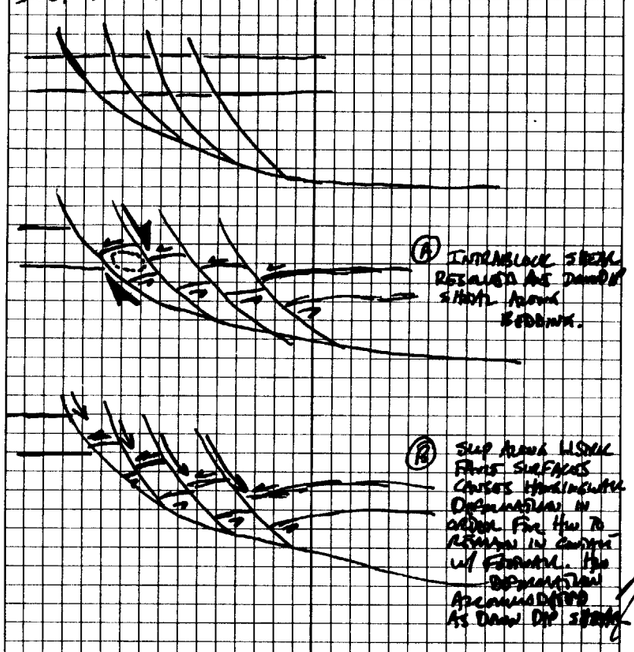
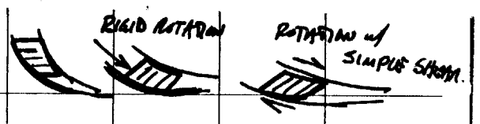
NOTE: LATE MESOSCOPIC FAULTS @ HIGH ANGLE TO BEDDING BRITTLELY OFFSET SHEARED STYLOLITES

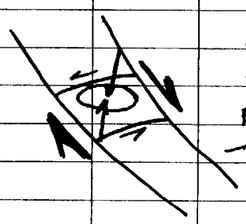
IDEA FOR DOWNDIP SHEAR:



138 4 Oct. '94.

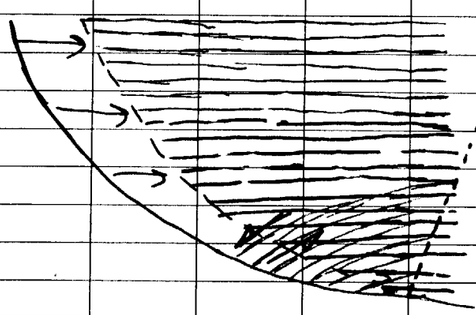


(A)



LAYER-PARALLEL SIMPLE SHEAR ASSUMED ACCOMMODATES FAULT BLOCK TRANSLATE, WILL TEND TO ROTATE DIP.

(B)



- ROTATION ACCOMPANIED BY LIMB DOWN DIP SIMPLE SHEAR IN RAMPART, ACCOMPANIED BY LIMB EXTENSION AND LIMB THINNING.

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NOTE:

WEST SIDE OF BARE MTN. EXPOSES BETTER CROSS SECTION THROUGH LISTRIC FAULT SYSTEM. FAULTS ARE MAPPED AS DIPPING EASTWARD. DIPS IN FAULT BLOCKS ARE GENERALLY UNIFORM.

→ MODEL:

BARE MTN. DOMINANT FAULT MECHANICALLY DIPPED W SUBSIDIARY ANTITHETIC AND SLIP WAS GENERALLY DIP SLIP ON LISTRIC ROTATING AND DIPS LOWER TO NW. (SEE DOMINANT FAULT SYSTEM. A LARGE (SYNCLINAL?) WARPING OF WEST SIDE OF RAMPART V.E.T. EAST SIDE CAUSED ROTATION OBSERVED FOLDING OR INTERNAL STRAIN ETC... RESULTING BEDDING DIPS INCREASED FROM ORIGINAL NW DIP TO DIPS TO THE NORTH. EARLY FORMED SIMPLE SHEAR DEFORMATION FABRICS (FOLD AXES, CLEAVAGE/BEDDING INTERSECTION ETC...) WERE ALSO ROTATED, AND LATER STRUCTURES DEVELOPED RELATIVE TO NOW. ORIENTATION BOTH OF SYNSEDIMENTARY AND ROTATED PRE-FAULTING DUCTILE DEFORMATION.

140 11 Oct. '94.

MODEL (cont'd.)

→ A PROBLEM WITH THIS MODEL IS THAT IT REQUIRES EASTWARD DIPPING, WHICH IS COUNTER TO WHAT IS CURRENTLY THOUGHT TO BE HAPPENING AS THE BARE MTN. FAULT CONTINUES TO SLIP.

NOTE: SHOW MODELS LATER AFTER LUNCH TODAY.

12 Oct. '94 141

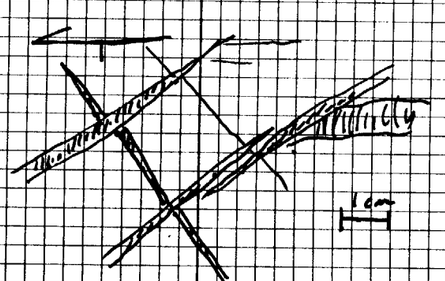
DAY 6 OF TECTONICS FIELD WORK

@ BARE MTN. NEVADA

DEBAUB - MD ESTANA

COLLECTED ORIENTED & ORIENTED SAMPLE FOR MICROSTRUCTURAL ANALYSIS

✗ 065/62 N — ORIENTATION MEASURED ON BEDDING.

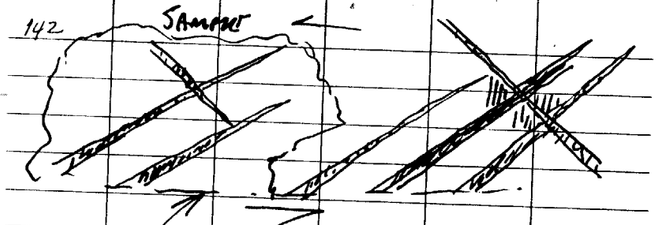


- WELL DEVELOPED FIBROUS VEINS CEMENT IN AT LEAST TWO SETS - FIBERS FIBERS ARRANGE IN PARALLEL DIP, MICROFOLDS OF VEIN ORIENTATION!

WHAT STRAIN SUGGESTED? OR FIBERS OPENING IN BOTH VEIN SETS.

12 Oct. 94.

142



~~[illegible]~~ SHEAR ZONE @ BASE OF SAMPLE.

Y 062/63N BEDDING - TAKEN ON SMOOTH LITHOLOGIC CONTACT.

- SAMPLE COLLECTED ~ 25 M FROM NEAREST DIKE ON EITHER SIDE, EAST AND WEST.
- VERY STRONG FABRIC LOCALLY DEVELOPED NEAR VEINS THAT SUGGESTS EITHER v. NARROW TEETH OR HIGH AMPLITUDE STYLOLITES, or GRAIN SCALE EXTENSION, PROBABLY AS WEIGHTNESS.

→ DRIVE THROUGH TITUS CANYON TO DEATH VALLEY. FRACTURED - PEBBLE CONGLOMERATE (TERT.). MORE EVIDENCE OF DOWNDIP SHEAR IN ~~[illegible]~~

13 Oct. 94 145

DAY 7 OF TECTONICS FIELD WORK @ BARE MTN.

= K. SPIVEY'S 13.2 & 13.3.

DFBM29 - Lower member of Proterozoic Wood Canyon Formation (Unit C). Zwlc

Coarse grained limestone sample for microstructural analysis

SAMPLE MARKED on bedding.

Y 071/45N BEDDING.

123/62N EXTENSION VEINS COMMON IN OUTCROP.

Sample collected 2 m west of diorite dike (alizarine?)

DFBM30 - ELEPHANT FM on RADIO TOWER HILL

Black coarse grained limestone

Y 157/60N - Marked on bedding

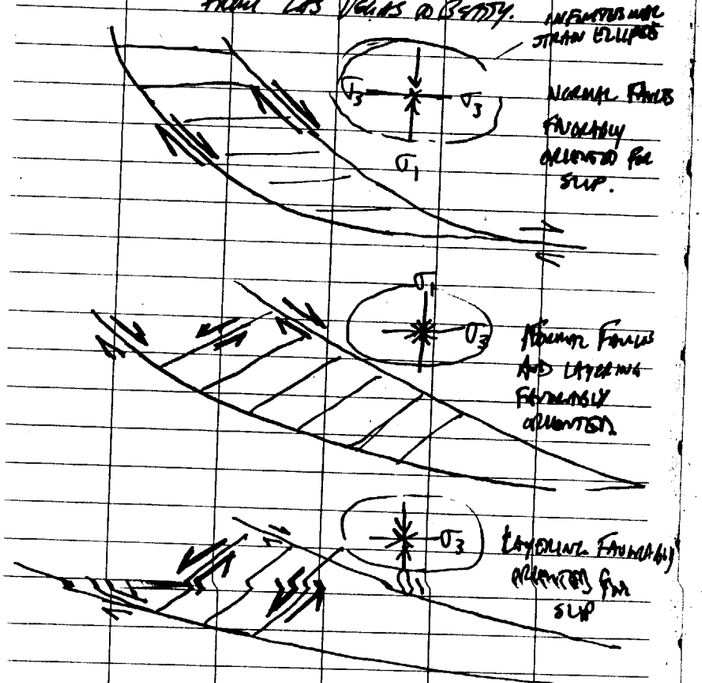
↳ sample for microstructural analysis.

144 19 October 1994 (WEDNESDAY)

FLEW SAN ANTONIO - LAS VEGAS. DRIVE TO BEATTY, NV, TO PARTICIPATE IN NRC/CARTERS GPS CAMPAIGN

BACK IN BEATTY, NEVADA.

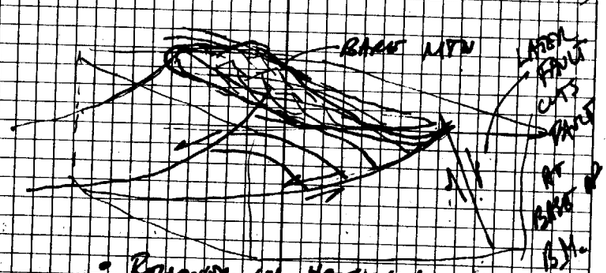
THOUGHTS FROM DRIVE LAST NIGHT FROM LAS VEGAS TO BEATTY.



19 Oct '94 145

IDEA FOR.

45° PLUNGE OF BARE MTN (NORTHEASTWARD)



- RELIEVED IN HANGINGWALL OF LISTRIC NORMAL FAULT.

20 Oct. '94.

NOTE: RECORDED SEVERAL NOTES ABOUT GPS FIELD CAMPAIGN IN SEPARATE FIELD NOTEBOOK.

146 21 OCT. 1984.

BEATTY, NEVADA. GAS STATION COMPLEX. RELOADED w/ 6 GAGE RIFLE AND @ STATION WAGON, DROVE 8 MILES NTH. @ NEVADA TEST SITE.

IDEAS FOR ANTIFORMIC LAYER-PARALLEL SHEAR.

MODELS:

- ANTIFORMIC SHEAR TO LISTRIC FAULT
- RESPONSE TO FAULT-PARALLEL SIMPLE SHEAR - THINS FAULT BLOCK.
- RESPONSE TO "GLACIER" FLOW SHEAR. IN CONJUNCTION W/ OR REPLACING FAULT SLIP AS MAJOR DEFORMATION MECHANISM

COMMENTS:

→ AS IN COMPRESSIONAL LAYER-PARALLEL SHEAR, SHEAR MAY BE CONCENTRATED IN CERTAIN HORIZONS WHICH WILL RESULT IN VARIATIONS IN Ψ THROUGH STRATIGRAPHY. E.g. 30° ANGLE BETWEEN STYLOLITE TEETH AND

22 OCT. '84. 147

HEADING SOON IN CARBONATES AS NOT COMING OFF OF CHARIOT CANYON

→ TO STUDY ANTIFORMIC LAYER PARALLEL SHEAR, SHOULD PICK EXAMPLES AND MEASURE SECTION THROUGH STRATIGRAPHY AND RECORD INFORMATION NECESSARY AND AMOUNT OF SHEAR THROUGH PROFILE. WILL NEED Ψ VALUES TO TEST MODELS. (e.g. ① CHARIOT CANYON or ② WEST CANYON WHERE IT CROSSES CHARIOT CANYON. FOR LARGE EXAMPLES (THICK SHEAR SEQUENCE). ③ SMALLER EXAMPLES AT CANYON N OF CHARIOT CANYON WHERE CARBONATE BEDS ARE AT BASE OF CLASTIC FILL).

148 22 OCTOBER 1984

LEFT GOLDFIELD, NV, AT 6:15 AM w/ PEDRO EL TO DRIVE TO TIN PASS TO QUARRY "TIN PASS" GAS STATION.

SET UP AND STARTED RECORDING AT 9AM. PROGRAMMED TO CONTINUE UNTIL 5 PM.

DRIVING AROUND SOUTH OF TIN PASS. AT LAST BURRO FEEDING GAP.

- ABUNDANT EVIDENCE FOR DOWNDIP SHEAR. DOWN-DIP-VERGENT (CM SCALE) CLEAVAGE, SIMPLE/DOWNDIP-VERGENT ASYMMETRIC FOLDS. LARGER (10's OF METERS) SCALE DOWNDIP-VERGENT ASYMMETRIC FOLDS ON N. SIDE OF CANYON (LOOK BACK) AS CROSS INTO HIDDEN VALLEY TO EAST.
- "RANDOM" ARRANGEMENT OF BELEMNITES IN PLANE OF BDG. SUGGESTS LOW STRAIN IN PLANE OF BEDDING

22 OCT. '84. 149

- TIN PASS MINERAL HOUSE HOUSE.

⇨ DRIVE HIDDEN VALLEY, WINTER WITH → PASS BW PHANTOM & SALINE VALLEY, RIPPINGOFF MAKE RD. (GRAVEL!!!) RACETRACK VALLEY → PICKED UP PEDRO AT 6 HEADED EVENTUAL → TRAILED UP TO SEE SNOW AT 7,000' ABOUT HALF WITH AND REGIONAL CONTACT.

→ HAS ANYONE HAS NOT/CARED ABOUT ANY SUGGESTION OF 45° PLUNGE OF BM, BUT ON OTHER HAND THESE TYPE MARKS NOT OF SCALE, AND GRADUATE HIGHER NEXT ON NW SIDE OF MTN. HAS ANISOTROPIES DUE TO LAYER OF PLUNGE OF COMPLEMENTARY FOLD PAIR w/ PLUNGE DIRECT (IF SUGGESTED PASSIVE TRANSPORT)

→ ALSO, ARE LINES SOMEWHAT AWAY THE CONVERGENCE OF FOLD w/ RAMP AS PART OF REGIONAL CONFIGURATION w/ DETACHMENT.

→ PLACE INTO - REGIONAL FACIES - STRETCHED MILES - CARBON-ARGILLITE FACIES.

150 22 Oct. 94

EDGE

→ SUGGESTS MAKING GRAVEDIMETS TO NORTH OF MOTEL PARKING' PAD AREA (REYNOLDS 1969. PAD Thesis Building).

→ EDGE HAS DONE THE PALEOMAG. WORK @ JOHN GEISSMAN'S LAB.
. 4 SITES SAMPLED FROM BASE LAVA.
2 SITES AT QTZ LATITE DIKE IN TRAVERTINE CANYON. DIKE AND WT 2° OF SCHNEIDER'S SAMPLES AGREES, PLUS SEVERAL ADDITIONAL CORES. FOUND NO STATISTICALLY SIGNIFICANT DIFFER AT ALL. QUESTION SCHNEIDER'S SAMPLES DATA!
• PALEOMAG GROUP GIVES STRONG FEELING EDGE THINKS THAT MAGNETIZATION IN COTTONWOODS UNIT IS AND MAKES SENSE TO S.H. DOES THIS AGREE W/ CROSS-CUTTING RELATIONSHIPS AND SOME MAG. ORIENTATIONS IN MOST ROCK AGE IN IMMEDIATE VICINITY? THAT THIS IS WHAT HE SAYS).

23 Oct. '94 151

Appt. [KARL FINK (CUMMINS) SUGGESTS MEETING W/ MR BRENDAN DUANE (Sp.?) AT GSA. USE AVO W/ WARNER.]

• EDGE SAYS THAT SCOTT ELLIOTT'S MASTER'S THESIS WORK IS BEING THAT REMAP. CARRIED BY NUMBER OF SMALL NORMAL DISPLACEMENTS (FAULTS & JOINTS?)
• EDGE THINKS THAT REMAP OF SEES COULD BE ACCOMPLISHED W/ FIELD MAPPING FROM TWO (2) PHASES.

152 23 Oct. 94 (SUNDAY)

→ SET UP "BLACK" GPS STATION W/ GERRY STRICKLAND.

• STATION IS AT SW EDGE CORNER OF BASALT FLOW, ESW OF BLACK CONE IN CLOVER FLAT VALLEY.

• STARTED RECORDING AT 10:16 A.M. SCHEDULED TO CONTINUE RECORDING UNTIL 6 PM.

• DRIVE BACK TO BUNKHOUSE VIA TRAVERTINE CANYON. NO TIME TO COLLECT ADDITIONAL OS (FISSION TRACK) AND OAR (MICROPROBE) SAMPLES.

• CALLED OUT OF BUNKHOUSE AND DRIVE TO LAS VEGAS AIRPORT FOR FLIGHT TO SEATTLE FOR GSA MEETING.

23 Oct. 94 153

• NEED TO CONTACT ARCHIVES AT EDC CENTER TO ASSURE FUNDING OF GPS PROJECT.
• PROJECT IS FUNDED FOR 1 MORE YEAR.
• GERRY & STATE WOULD LIKE/NEED 3(?) MORE YEARS MEASUREMENT TO REDUCE ERROR/UNCERTAINTY FOR SITES WILL BE NECESSARY (REASONS?).
FUNDING LIKELY/NEED n = 6 or 7.
• FUNDING NEEDS ARE ~$50K/yr.
→ TALK TO LARRY/GERRY/? ABOUT SETTING UP CONTRACT TO ASSURE FUNDING NO PROBLEM.
→ WOULD BE GOOD TO GET INCREASE IN TRAINING BUDGET FOR NRC TO COVER TIMES WORK.

David A. Ferrill
Oct. 1994–

"Rite in the Rain"
ALL-WEATHER WRITING PAPER

Name David A. Ferrill
Southwest Research Inst. - Div. 20.
Address 6220 Culebra Rd.
San Antonio, TX 78240
Phone (210) 522-6082

Project

"Rite in the Rain" - a unique all-weather writing surface created to shed water and to enhance the written image. Makes it possible to write sharp, legible field data in any kind of weather.

J. L. DARLING CORPORATION
TACOMA, WA 98421-3696 USA

CONTENTS

PAGE	REFERENCE	DATE
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20 Oct. '94.

CALTECH/NRC Death Valley GPS Survey

- Meeting Meeting.
  - → Handed out plots to group.
  - → Errors noted on plots of GPS station locations.
  - 1. Order of Stations northwest of Panamint valley incorrect. From SW to NE, should be: Lee Flat, Flats, Jackass, Hunter Mtn.
  - 2. Agureberry station not included in plots. Need to get a new recent file of station locations from U. Davis.

4

20 Oct. 94.

- Discussion about results to date from GPS campaign. Jim Davis supplied handout w/ plot for Wakamie-Mile.
- May be some significant displacement among Lee Flat, Flats, Jackass, & Hunter Mtn. stations.
- Discussion of Oldows (Rice/UTD, Horn) GPS network. What is he trying to study? Are his stations plotted in true right locations? Need to talk to him @ GSA meeting. Give him copy of plots.

5

20 Oct. 94.

Participants present:

Brian Wernicke	CALTECH
Jim Davis	SAO
Karl Fleux	UNAVCO
George Birkhard	NRC
Gerry Stinewalt	CNWRA
David Ferrill	CNWRA
Pedro Elosegui	SAO
~~[illegible]~~ O. Rood	UNAVCO
Zeke Snow	CALTECH

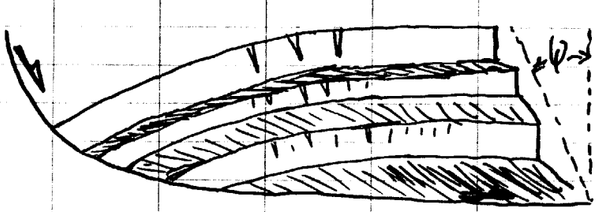
→ STOWED UP IN EVENING.

6

23 OCT. 1994.

EN ROUTE FROM LAS VEGAS TO SEATTLE FOR NATIONAL GSA MTG.

⇨ ADDITIONAL IDEA FOR HANGINGWALL DEFORMATION RELATED TO NORMAL FAULTING



- CONSTRAINED TO HAVE NO CHANGE IN LAYER THICKNESS. NOT REQUIRED THAT ALL DEF TAKEN UP BY SIMPLE SHEAR
- DIFFERENTIAL SHEAR OCCURS DUE TO RHEOLOGICAL SUSCEPTIBILITY TO SHEAR, AND THICKNESSES OF LAYERS IN SEQUENCE.

7

23 Oct. 94.

FIELDWORK FOR FY 95.

- BARE MTN. – MAP FAULT SYSTEM AT NORTHERN END.
  - COLLECT DATA TO CONSTRAIN CROSS SECTIONS (BM & EAST OF YM).
  - DEFORMATION MECHANISMS ASSOCIATED WITH EXTENSIONAL DEFORMATION.
  - ADDITIONAL SAMPLES FOR FAULT ZONE DEFORMATION STUDIES.
- DEATH VALLEY (AREA) – FAULT & DIKE INTERACTION @ BADWATER TURTLEBACK
  - FAULT & DIKE INTERACTION IN S. DEATH VALLEY.
  - GEOMORPHOLOGIC INDICATORS OF ACTIVITY OF DVFCFZ.
  - FAULT ZONE DEF. MECHS ON TURTLEBACK SURFACES.

8

23 Oct. '94.

- FISH LAKE VALLEY TURTLEBACKS (w/ JOHN OLDOW).
- RECONNAISSANCE FIELD WORK IN GRAPEVINE MTNS. TO CONSTRAIN CROSS SECTIONS & REGIONAL CONTEXT OF B.M.

LANDERS - ADDITIONAL FIELD RECON. ALONG SURFACE RUPTURE?

OWENS VALLEY - FAULT & DIKE INTERACTION AT BIG PINE & COSO.

SALINE RANGE - FAULT & DIKE INTERACTION.

MESA BUTTE - ADDITIONAL DATA TO CONSTRAIN MODEL OF FAULT GEOMETRY.
- MORE FRACTURE DATA.

REVEILLE RANGE - FAULT & DIKE INTERACTION

CRATER FLAT - 4 MY DIKES. MAP THEM.

9

23 Oct. '94.

1995 NRC/CALTECH GPS CAMPAIGN

→ ACTUALLY THIS WILL BE FY 96.

10

19 FEB. 1995

BARE MTN., NEVADA.

→ WEEK OF FIELD WORK: 19-24 FEB. '95
→ STAYING AT BURRO INN.
→ IN FIELD w/ ALAN MORRIS.
→ COMPASS DECLINATION SET ON 14.5°.

* PLAN:

- COLLECT ADDITIONAL FISSION TRACK SAMPLES @ BARE MTN.
- COLLECT FISSION TRACK AND POSSIBLY PALEOMAG. SAMPLES IN SAMPED HILLS.
- STUDY OUTCROP-SCALE NORMAL FAULTS IN CARBONATES ON WEST SIDE OF BARE MTN. (SAMPLE).
- SAMPLE ORDOVICIAN ANTELOPE VALLEY FORMATION IN FAULT BLOCKS AND ADJACENT TO NORMAL FAULTS NEAR CREST OF BARE MTN.
  → ALSO, SAMPLE VEINS IF POSSIBLE FOR OXYGEN-ISOTOPE AND FLUID-INCLUSION STUDIES.

19 FEB. 95

- CONSIDERING MEASURING SECTION THROUGH NORMAL FAULT BLOCK TO LOG DEFORMATION MECHANISMS AND IN PARTICULAR EVIDENCE OF DOWN DIP SHEAR. ACTUAL LOGGING OF SECTION MAY TAKE MORE THAN AVAILABLE TIME, BUT IDENTIFICATION OF A SECTION TO LOG WOULD BE QUITE USEFUL. LOG IF POSSIBLE.
- CONDUCT FIELD RECONNAISSANCE OF TITUS CANYON SECTION THROUGH GRAPEVINE RANGE. CONSIDER EXTENDING SUBREGIONAL CROSS SECTION ACROSS ~~GRAPEVINES AND TO~~ AMARAGOSA VALLEY AND GRAPEVINES TO DEATH VALLEY FAULT (AND BEYOND?).
- CONDUCT FIELD RECONNAISSANCE OF BASALTIC CONES (4 MA) DIKES AND FAULTS IN ALLUVIUM IN GREENWATER RANGE.
- CONDUCT FIELD RECON. OF NEOTECTONIC FEATURES OF DEATH VALLEY/FURNACE CR. FAULT ZONE.

19 Feb. 1995

- STUDY AND COMPARE ALLUVIAL FANS ON EAST & WEST SIDES OF BARE MTN.
- CONDUCT FIELD RECON. OF INTERPRETED SLUMP @ SE END OF BARE MTN. TROUBLE WITH BARE MTN. ROCKS APPARENTLY OVERLIE TERTIARY? ROCKS.
- SAMPLE EXAMPLES OF DOWN-DIP SHEAR.

NOTE: IT WILL BE IMPOSSIBLE TO COMPLETE THE WORK LISTED ABOVE IN 4 1/2 DAYS. PRIORITIZATION WILL CONTINUE AS THE WORK PROGRESSES.

20 Feb 1995

BARE MTN., NEVADA

COLLECTING ADDITIONAL SAMPLES FOR FISSION TRACK ANALYSES.

DFBM31 - ORDOVICIAN EUREKA QUARTZITE. 4 SAMPLES COLLECTED FOR FISSION TRACK ANALYSES.

DFBM31.1
DFBM31.2
DFBM31.3
DFBM31.4

→ DOWNSLOPE FROM THIS SAMPLE LOCALITY ABUNDANT VEINS IN CARBONATE FLOATS. ALSO, BRECCIA CONSISTING OF LIMESTONE CLASTS IN SILICEOUS MATRIX SEEN IN FLOAT

→ DFBM31.5 ⇒ FLOAT SAMPLES OF CARBONATE w/ VEINS.

20 Feb. 1995

DFBM32 - Ordovician Eureka Quartzite SAMPLED FOR FISSION TRACK ANALYSES. ~1/2 MI. N. OF DIAMOND QUEEN MINE FIVE SAMPLES

DFBM32.1 → DFBM32.5

NOTE → Qe quartzite here is medium to dark grey. Qe at station DFBM31 is white.

DFBM33 - STERLING QUARTZITE (Tse)

IN OR IMMEDIATELY S. OF DIAMOND QUEEN MINE (ACCESSED BY ROAD FROM SOUTH.

4 SAMPLES COLLECTED FOR FISSION TRACK ANALYSES
DFBM33.1 → DFBM33.4.

20 Feb. 95

DFBM34 - Zabriskie Quartzite (Cambrian).

5 SAMPLES COLLECTED FOR FISSION TRACK ANALYSES.

(DFBM34.1 → DFBM34.5)

1 SAMPLE OF VEIN QUARTZ COLLECTED FOR FLUID INCLUSION ANALYSIS.

(DFBM34.6) FULL WIDTH OF VEIN COLLECTED

VEIN: ∠ 032/45SE
∠ 024/53 SE
∠ 037/65SE

BEDDING:
⊥ 104/83N
⊥ 100/63N
⊥ 093/68N.

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20 Feb. 1995

DFBM35 - Unit "a" of Sterling Quartzite.

Collected two samples for fission track analyses from footwall of fault immediately south of Steve's Pass.

DFBM35.1 & DFBM35.2

STRIPED HILLS -

~~DFBM SH1~~ DAF
DFSH1 - Zabriskie Quartzite in striped hills.

3 samples collected for fission track analyses.
DFSH1.1 → DFSH1.3.

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20 Feb. '95.

Guesses on timing of onset of most recent uplift.

Alan Morris → 9.25 MA
David Ferrill → 7.0 MA

DFSH2 - Wood Canyon Formation

Wood Canyon Formation @ S. end of striped hills samples for fission track analysis.

4 samples collected.
DFSH2.1 → DFSH2.4

DFBM36 - ~~Sterling~~ Zabriskie Quartzite ~~(Zsdy)~~ (Ez)

Six quartzite samples collected for fission track analyses.

Numbered
DFBM36.1 → DFBM36.6.

JAF

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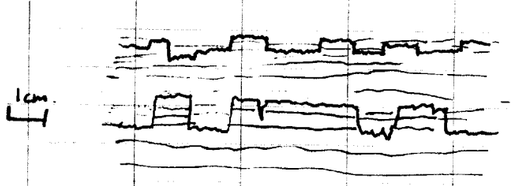
21 Feb. '95

Bare Mtn. Nevada -

Hiking to crest of ridge to sample Antelope Valley Fm. (OAV) and to study intra-fault-block deformation mechanism.

DFBM37 - Photographs of ~~St~~ Bed-⊥ stylolites in carbonates. No evidence of layer-// shear of stylolites. (Ebbl)

- Have observed many meso-scale faults, veins and joints. Faults tend to be at high angle to bedding and accommodate ~ bed-normal shortening.



⊥ 090/36N bedding orientation @ location of photos.

19
21 Feb. '95

DFBM38 - Normal fault ~~contact~~

Og on top of Ebbu.

- Photos taken looking along trace of fault to ridge.
- Photo's of hangingwall and fault zone.
- Photo's showing discordance between a second // fault lower than mapped fault

Hangingwall

Y 045/62 NW bedding. (may not be representative of overall H.W. orient.)

↑ 030/35 bearing and plunge of intersection of mesoscopic extensional faults and bedding.

DFBM39 - Sample of carbonate from hangingwall ~30m above fault contact. Rock in places virtually blown apart. Vein fill is multiphase in places. Dominantly carbonate (poss. DOL & calcite) and quartz.

JAF

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21 Feb. '95

ANGULAR CLASTS OF HOST ROCK VIRTUALLY FLOATING IN VEIN-FILL.

SAMPLES COLLECTED FOR STABLE ISOTOPE (O, C) AND POSSIBLY FLUID INCLUSION ANALYSES.

DFBM39.1 DOL & QTZ VEIN MATERIAL
DFBM39.2 ANGULAR CLASTS "FLOATING" IN VEIN MATERIAL.

DFBM40 - FAULT ROCK.

→ PHOTO'S OF FAULT ROCK.

DFBM41 → PHOTO'S LOOKING N ALONG FAULT
- PHOTO'S OF BULLFROG MINE (LACK MINERALS) IN DISTANCE.
- PHOTO'S OF DISSECTED FANS/SAHADA ON W. SIDE BARE MTN. AND EAST DRAINING DISSECTED FANS ON E SIDE OF GRAPEVINES.
- PHOTO'S OF PANOMINTS IN DISTANCE

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21 Feb. '95

DFBM42 - BEDDING-PARALLEL VEINS IN HANGINGWALL. APPEARS THAT FLUID INJECTED PARALLEL TO BEDDING FRAGMENTING ROCK INTO PLATES, PARALLEL TO SURROUNDING BEDDING. ZONES ON SCALE OF 10'S OF CM TO ~1 m HAVE ≥ 50% VOLUME GAIN BY DOLOMITE VEINS. VEIN ZONES ARE SPACED M'S TO 10'S OF M APART. ZONES LATERALLY CONTINUOUS FOR AT LEAST 10'S OF METERS ALONG BEDDING.

DFBM43 - Cleavage in Ordovician Nirenule Fm. (Oa) Pelite Verges down dip @ low angle to bedding
- 065/41 N BEDDING
- 090/23 N CLEAVAGE

- Suggests down-dip shear.

DFBM44 - Cleavage in Ordovician Nirenule Formation (Oa)
- 111/31 N CLEAVAGE
- 087/45N BEDDING

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21 Feb. '95

DFBM45 - ORDOVICIAN ANTELOPE VALLEY FORMATION (OAV) SAMPLED FOR MICROSTRUCTURAL ANALYSIS.

→ NOTE: TOOK PHOTO'S LOOKING W. AT ALLUVIAL FANS

DFBM45.1 → FOSSILIFEROUS BED - 2m ABOVE FAULT PLANE.
- 105/34N ORIENTATION MEASURED & MARKED ON BEDDING.

DFBM45.2 → FOSSILIFEROUS BED ~2m ABOVE FAULT.
- 091/28N MEASURED & MARKED ON BEDDING

DFBM46 - ORDOVICIAN ANTELOPE VALLEY FM. (OAV). SAMPLED FOR MICROSTRUCTURAL ANALYSIS.

DFBM46.1
- 071/30N BEDDING. (ORIENTATION MARKED ON UPPER BEDDING PLANE ON SAMPLE.

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21 Feb. '95

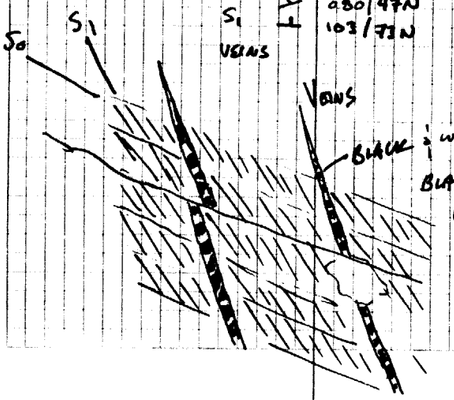
DFBM47 - ORDOVICIAN ANTELOPE VALLEY FOSSILIFEROUS BED SAMPLED FOR MICROSTRUCTURAL ANALYSIS.

DFBM47.1
- 073/37N BEDDING. MARKED ON UPPER BEDDING SURFACE.

DFBM48 - ORDOVICIAN ANTELOPE VALLEY FM. FOSSILIFEROUS C.G. LIMESTONE COLLECTED FOR MICROSTRUCTURAL ANALYSIS

DFBM48.1 -
- 084/38N MARKED ON BEDDING (TOP SURFACE)

S_0 085/35N
S_1 080/47N
VEINS 103/73N



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21 Feb. 95

DFBM48.2 } SAMPLES OF EXTENDED/BOUDINAGED
DFBM48.3 } BLACK VEINS COLLECTED FROM FLOAT. NOT ORIENTED.

NOTE: THIS CLEAVAGE & BOUDINAGE OF VEINS IS EVIDENCE OF UPLIMB SHEAR AND ~~IS, AS SUCH~~ SEEMS TO BE UNUSUAL/ATYPICAL FOR/IN THIS AREA.

DFBM49 - ORDOVICIAN ANTELOPE VALLEY FM.
SAMPLE COLLECTED FOR MICROSTRUCTURE.
DFBM49.1 →
Y 066/47N BEDDING - MARKED ON UPPER BEDDING SURFACE

DFBM50 - ORDOVICIAN ANTELOPE VALLEY FM COLLECTED "ADJACENT" TO FAULT.

DFBM 50.1
Y 058/36N - BEDDING - 20 M BELOW FAULT (⊥ FAULT)
DFBM 50.2
Y 067/36N - BEDDING. 25 M BELOW FAULT (MEASURED ⊥ FAULT).

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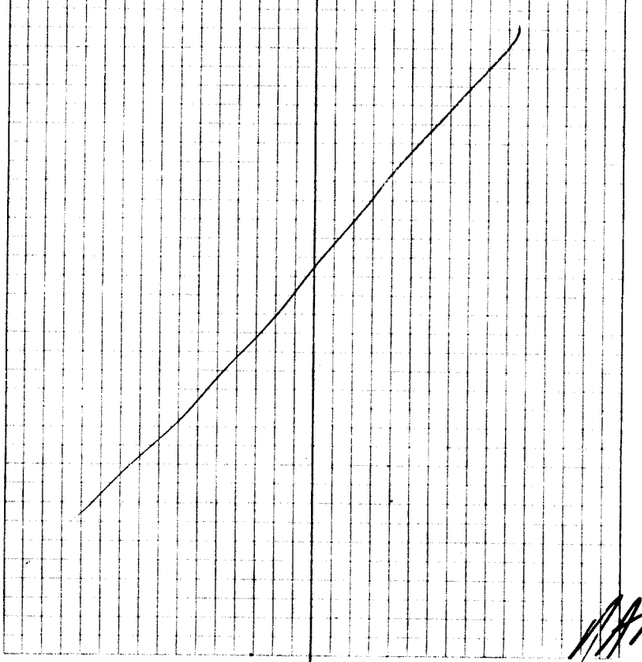
21 Feb. 95

DFBM51 - ORDOVICIAN EUREKA QUARTZITE.
5 SAMPLES COLLECTED FOR MICROSTRUCTURAL ANALYSIS.
DFBM 51.1 - DFBM51.5



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22 Feb. 1995

BARE MTN, NEVADA

- ANOTHER BEAUTIFUL DAY!

DFBM52 - STERLING QUARTZITE. (Zsdu)
SAMPLES COLLECTED FOR FISSION TRACK ANALYSES.

5 SAMPLES COLLECTED FOR FISSION TRACK ANALYSES.
NUMBERED
DFBM52.1 → DFBM52.5

⊥ 099/20N BEDDING.

DFBM53 - Ꞓbp. PAPOOSE LAKE MBR. BONANZA KING FM.
SAME LOCATION AS DFBM 37.
~~EXAMPLE~~
SAMPLE OF MARBLE W/ DOWN-DIP SHEARED STYLOLITES COLLECTED FOR MESO AND MICROSTRUCTURAL ANALYSIS.

27
22 Feb. 95

DFBM54 - DARK GREY LIMESTONE CONTAINING DEFORMED WHITE FOSSILS (CRINOID STEM FRAGMENTS FOR EXAMPLE). ROCK HAS PROTOMYLONITIC TEXTURE IN HAND SAMPLE. TWO SAMPLES COLLECTED FOR MICROSTRUCTURAL ANALYSIS.

DFBM54.1 - Y069/53N MARKED ON BEDDING

DFBM54.2 X 170/97 MARKED ON FRACTURE SURFACE.

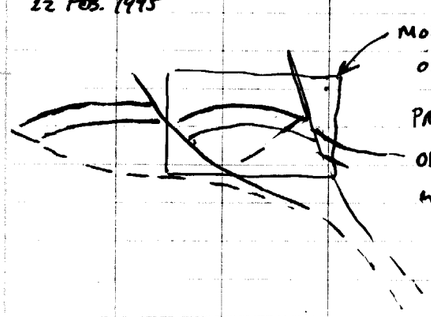
Y 075/55N BEDDING

π 107/39S } CALCITE FILLED EXTENSION VEINS
π 105/43S }
→ VEINS APPEAR TO ACCOMMODATE ~5% ~DOWN-DIP EXTENSION. (LATE-BRITTLE DEF.).

DFBM55 - FAULTS WITHIN Ꞓbp.
FAULT ZONE ~ ½ - 1 m THICK.

28

22 FEB. 1995



(PRELIMINARY NOTES FROM PRIOR TO ABOVE SKETCH)

FAULT ZONE EXPOSED AS SLIGHT BENCH IN CLIFF.

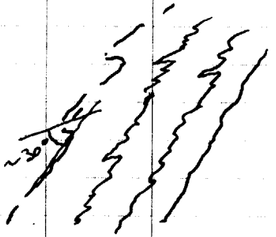
FAULT ZONE ~½ - 1 m THICK

DISPLACEMENT ~ [illegible]. 15m? (OR MAYBE FOR MAJOR FAULT)

ORIENTATION OF FAULT ⊦ 015/85E.

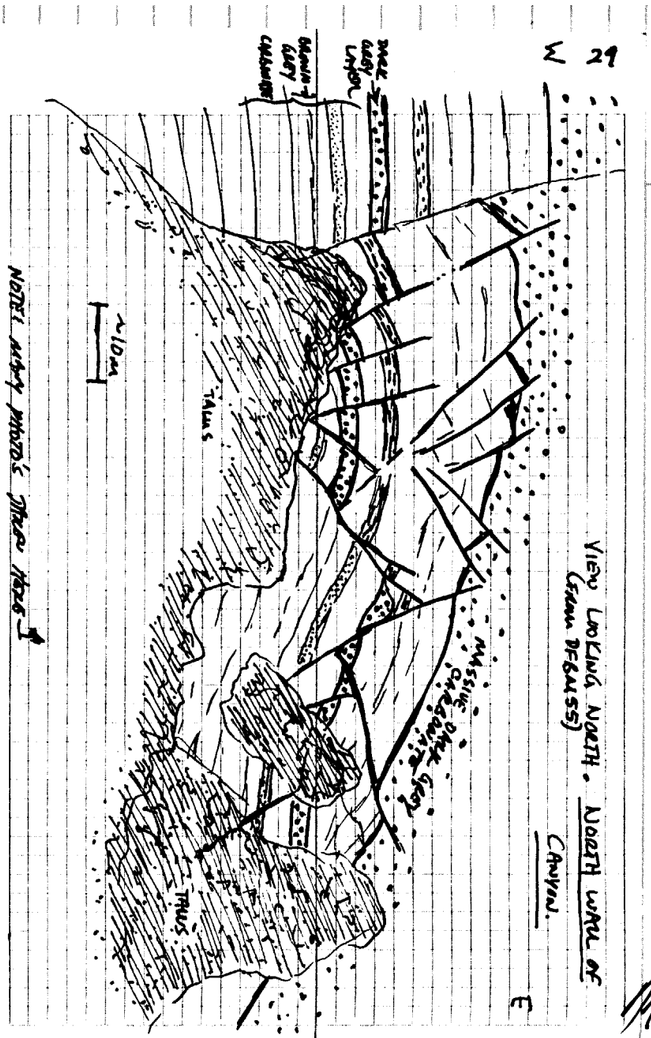
SHEARED STYLOLITES COMMON IN HANGINGWALL

BEDDING (HANGINGWALL)
Y 050/80N



↑ PHOTOGRAPH TAKEN OF THIS

29



30

22 FEB. 1995

ORIENTATIONS OF BEDDING AND FAULTS MEASURED AT LOCATIONS MARKED ON DRAWING ON FACING PAGE. MANY PHOTOS TAKEN AT THIS OUTCROP.

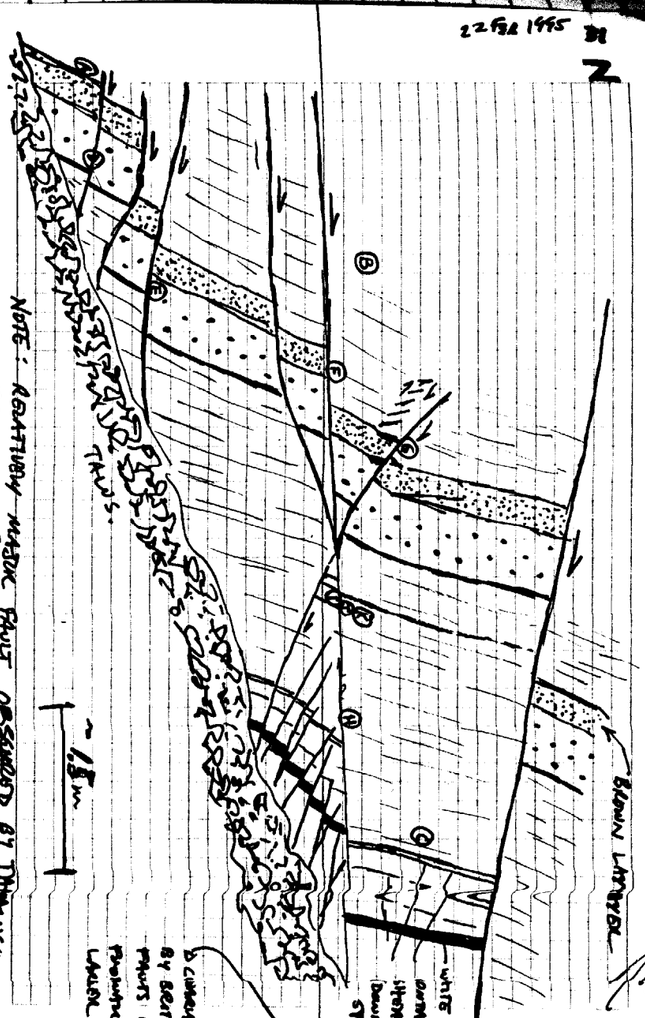
BEDDING
- (A) Y 067/78N
- (B) Y 062/62N
- (C) Y 063/70N

EXTENSION FAULTS
- (D) ⊦ 015/55E
- (E) ⊦ 010/31E
- (F) ⊦ 158/30E
- (G) ⊦ 033/65E
- (H) ⊦ 177/26E

(I) DFBM55.1 55/62 → ORIENTATION ON FRACTURE. FOOTWALL SAMPLE ADJACENT TO FAULT
(J) DFBM55.2 Y 073/73N ON BOTTOM BEDDING
(K) DFBM55.3 Y 065/77N ON BOTTOM BEDDING

SAMPLES J AND K ARE ADJOINING SAMPLES OF SAME BED. THE BOTTOM END CUTOFF OF J IS THE FAULT. SAMPLE K IS FURTHER INTO HANGINGWALL.
J AND K → OOLITIC LIMESTONE W/ WELL DEVELOPED PENETRATIVE SHALE FABRIC THAT SUGGESTS DOWN-DIP SHEAR.

22 FEB 1995 31

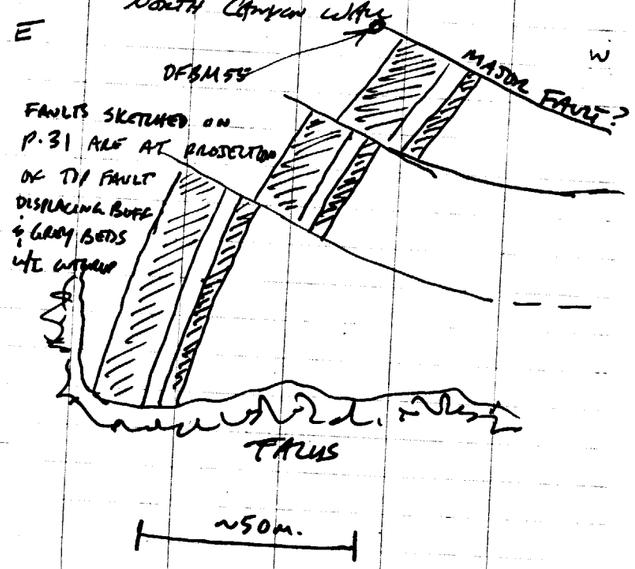


32

22 Feb. '95

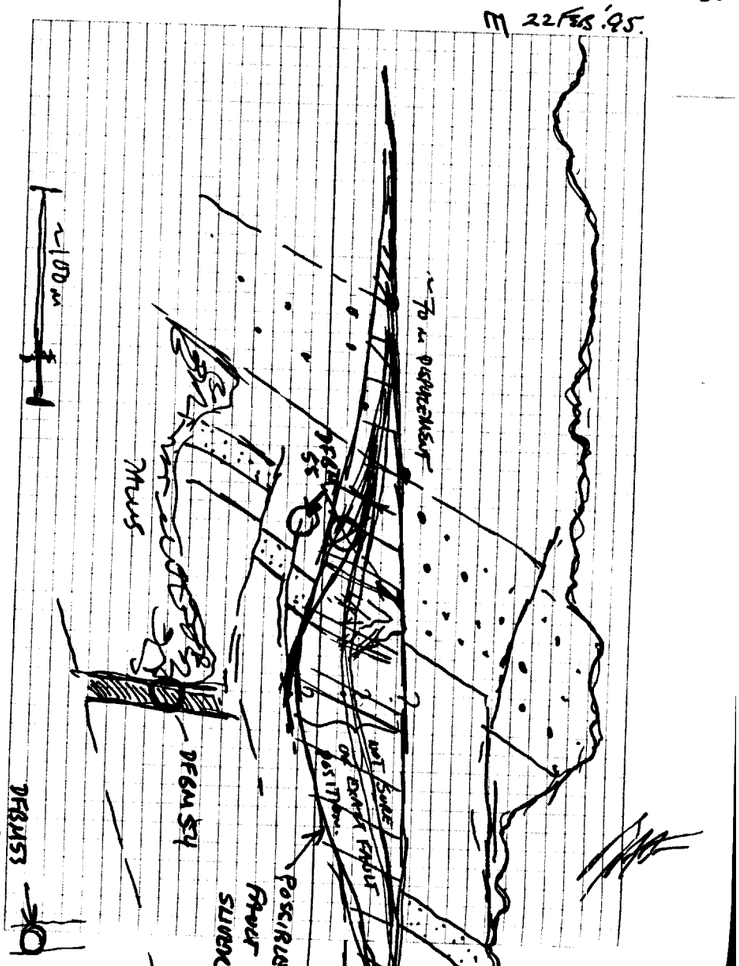
DFBM56 - Photo of normal faults cutting dolomite and limestone layers.

ES
Sketch on facing page is view looking south at south canyon wall from this location on north canyon wall



33

E 22 Feb. '95.



34

22 Feb. 1995

DFBM57 - Zsdu - Sterling Quartzite sampled for fission track analysis.

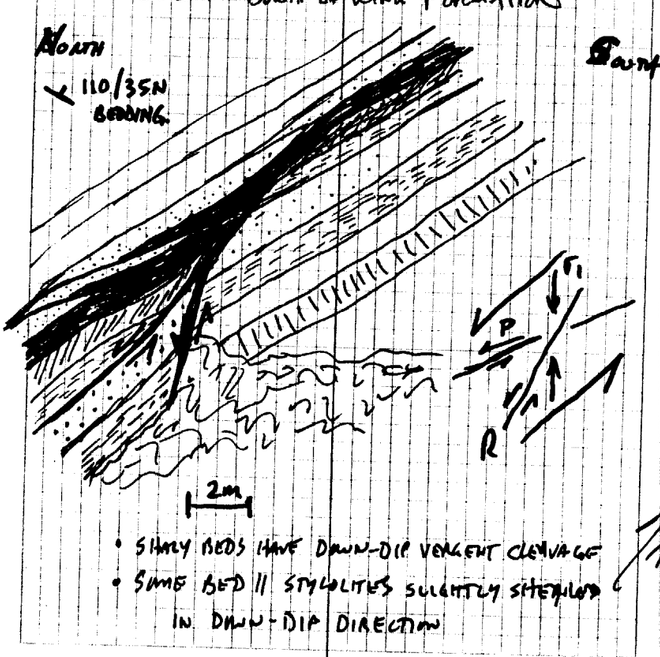
35

23 Feb 1995

Titus Canyon - Death Valley National Park

DFTC1 -

Cambrian Bonanza King Formation



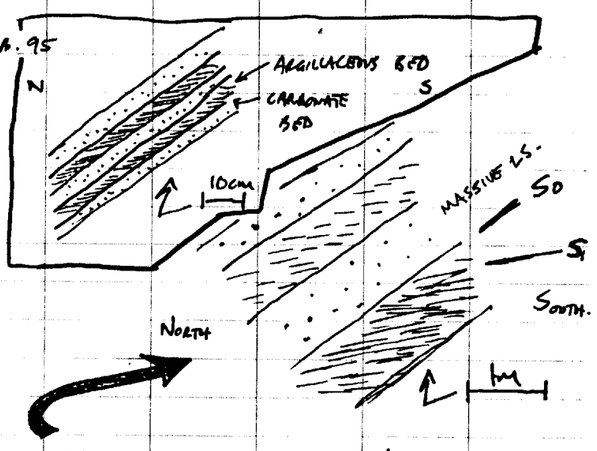
- Shaly beds have down-dip vergent cleavage
- Some bed II stylolites slightly stretched in down-dip direction

96

97

36

23 FEB. 95



BEDDING	097/35N
CLEAVAGE	169/29E
CLEAVAGE	131/31N
CLEAVAGE	150/41N
BEDDING (AVG)	105/38N

NUMEROUS PHOTOS OF:
- BEDDING & CLEAVAGE
- SHEARED STYLOLITES
- OUTCROP W/ FAULTS SKETCHED ON PREVIOUS PAGE.

DFTC2 - VEINS OFFSET BY BEDDING PARALLEL AND LOW ANGLE TO BEDDING SLIP SURFACES.
- 4 PHOTO'S

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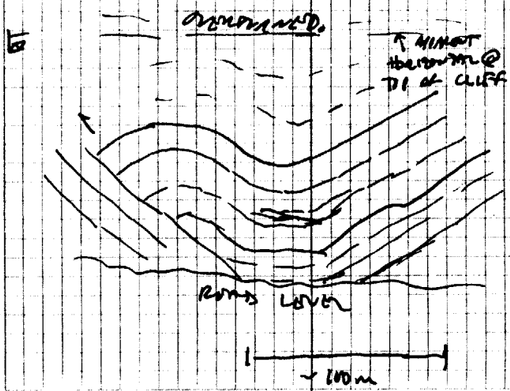
23 FEB. 95.

DFTC3 - BEDDING ⊥ VEINS OFFSET BY BED-PARALLEL SLIP SURFACES W/ DOWN-DIP SENSE OF SHEAR.
- BEDDING-⊥ SLIP SURFACES OFFSET BY BRITTLE EXTENSIONAL FAULTS.
- PHOTO'S OF THESE RELATIONSHIPS TAKEN. (GREY LS & BROWNISH MARLY LAYERS (~cm scale))

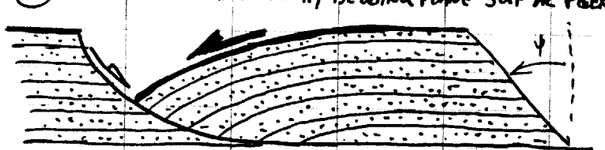
DFSMTC4 - PHOTO'S OF FOLDS. STRATA ARE MAPPED BY M. REYNOLDS TO BE DECOLLEMENTED.



23 FEB. 1995

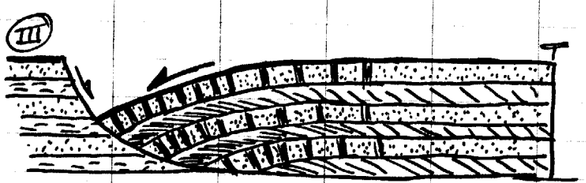
MODELS FOR DOWN-DIP SHEAR RELATED TO EXTENSIONAL FAULTING

(I) UNIFORMLY DISTRIBUTED BY BEDDING PLANE SLIP OR FLEXURAL FLOW.



(II) LOCALIZED AS SLIP OR FLOW AT DISCRETE HORIZONS/UNITS

(III)



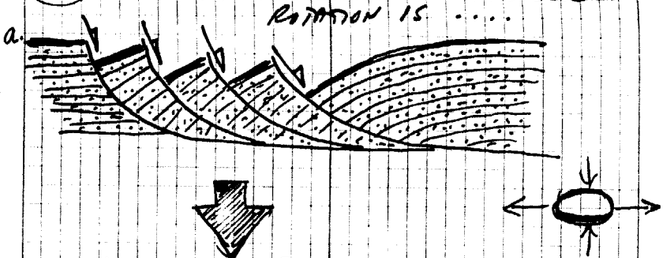
(NOTE: ALAN SUGGESTED THIS ON 21 FEB. 95 WHILE CLIMBING AND SAMPLING BARE MOUNTAIN).

37

23 FEB. '95

(IV) INITIAL FAULT SLIP WITH RIGID BLOCK ROTATION IS ....

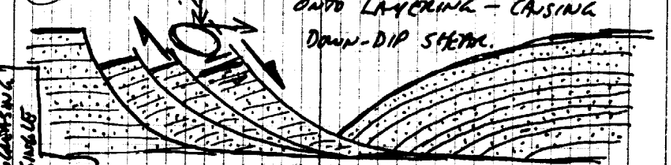
a.



PARTIALLY REPLACED BY BEDDING PLANE SLIP TO ACCOMMODATE EXTENSION

b.

(V) FAULT-PARALLEL SIMPLE SHEAR REGOLUCED ONTO LAYERING - CAUSING DOWN-DIP SHEAR.



TEST PARAMETER	I	II	III	IV	V
DOWN-DIP SHEAR EARLY	✓	✓	✓	X	✓
DOWN-DIP SHEAR LATE ONLY	X	X	X	✓	X
LAYER-PARALLEL EXTENSION CRITICAL (STIFF BEDS)	OK	OK	✓!	OK	OK
SHEAR FLAT ON FLAT	✓?	✓?	X	X	X
SHEAR ↑ W/ RELATIVE DIP	✓	✓	✓*	X	X
SHEAR ↓ W/ RELATIVE DIP	X	X	X	✓	✓

* SHEAR MAY INCREASE W/ INCREASING RELATIVE DIP WITHIN A SINGLE STRUCTURE.
? SEE MODIFICATIONS ON NEXT P.

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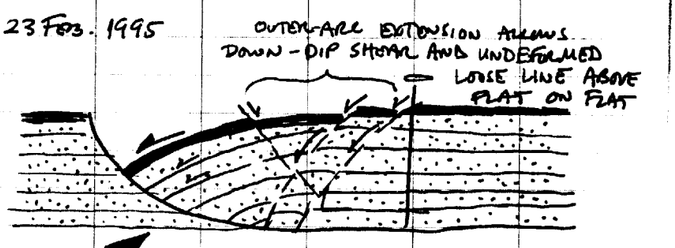
23 Feb. 1995



MODIFICATION OF MODELS I AND II.

41

42

2 May 1995

LAS VEGAS – DEATH VALLEY REGION
RECONNAISANCE FIELD WORK.

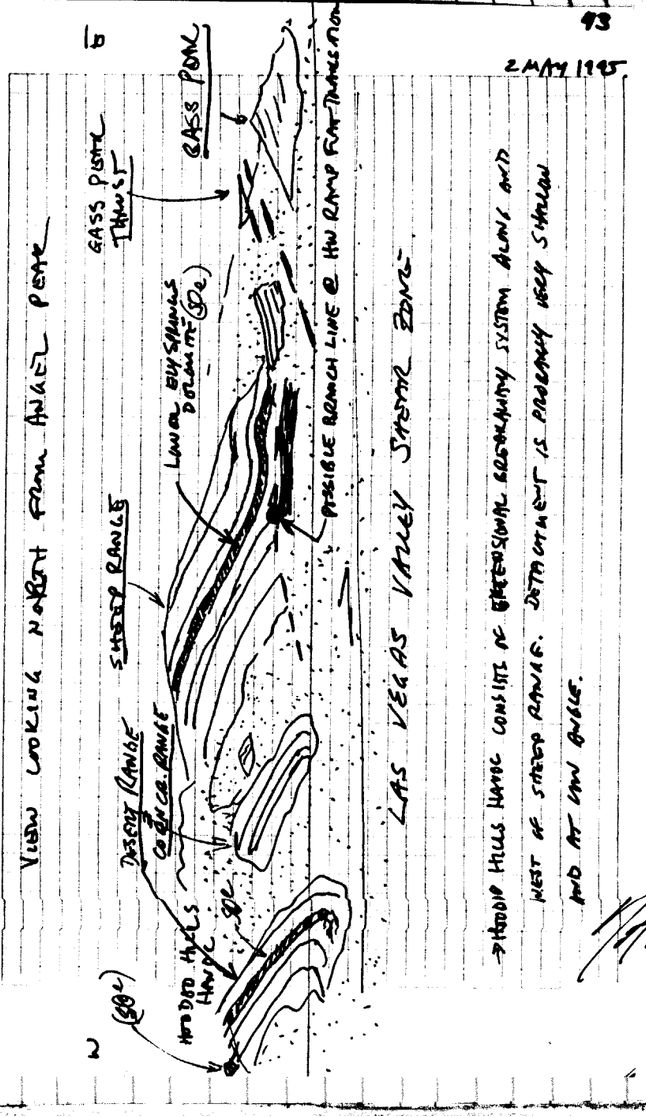
FIELD PARTY: J. KENT "ZERE" SNOW (CARTETH)
JOHN STAVATAKOS, DAVID FERRILL.
U. MICHIGAN

PURPOSE OF FIELD WORK: STUDY REGIONAL STRUCTURAL TECTONIC FEATURES THAT CONTRIBUTE SIGNIFICANTLY TO REGIONAL TECTONIC MODELS AND INTERPRETATIONS.

STOP 1 – ANGEL PEAK – RADAR STATION AT SPRING MTN. YOUTH CAMP. IGCP FIELD TRIP GUIDE STOP #4.3. (GUTH STOP) T138 → WERMICKE et al. 1989.

43

2 MAY 1995



44

2 MAY 1995.

ACROSS N VALLEY SPRING BANK.

→ OFFSET THRUST FAULTS INDICATE 60km RIGHT SLIP.

- GASS PEAK THRUST CORRELATED W/ HARRISON PASS THRUST (IN SPRING MTNS).
  - STEEP HW & FW RAMP
  - 5-6 KM STRAT. THICK
  - FIRST OCCURRENCE OF ED CAMBRIAN RX IN RANGELAND
  - PINCH-IN OF SILURIAN IN FOOTWALL.
  - FIRST THRUST ABOVE KEYSTONE THRUST.

- KEYSTONE THRUST (SPRING MTNS.) MUDDY MTN., GLENDALE, AND MORMON MTN. THRUSTS TO NORTH ARE CORRELATED ACROSS LAS VEGAS VALLEY SHEAR ZONE.
  - DETACHMENT IN SILTY UNITS OF BONANZA KING.
  - COMPLEX FOLDING ASSOCIATED W/ OVERTURNED ANTICL. TO W & SYNCL. TO E
  - TIGHT & LOCALLY RECUMBENT FOLDING SYNCLINE.

45

2 MAY 1995.

BURCHFIEL, HAMILL & WILLIAMS. 1982.
GSA Map & Chart Series MC 44.

→ Montgomery Mtns. Map - Burchfiel mapped isopach relationship in middle Stirling Quartzite that suggests 10km right slip. (would be close up Stewart Valley).

→ All stratigraphical say RL SS < 25 km.

→ Schweickert models ≥ 25 km RL SS @ Stewart Valley -

* This could be quite important for Bare Mtn, Cane Flat, Yucca interpretation.

Also - Schweickert looks at Sargent structure @ BM of Striped Hills. BM → middle Wood Canyon - deep water, also Carrara. At Striped Hills, middle Wood Canyon shallower water & also Carrara shallower water. Presents problem for Schweickert's model.

46

2 May 1995

A.R. "Rube"

→ Palmer & Halley - 1979. U.S.G.S. Professional Paper on Carrara.

→ Tony Prave also talk about this Paleozoic stratigraphy.

* Mercury Klippe - stratigrapher heart of structural models.

Keeley & Schweickert vs Snow and Wernicke.

→ Oslager & Monterey → @ UC Riverside. Cambrian (Bonanza King) stratigraphers.

Drive Oslager → if stiff money and would be great to have money subbie.

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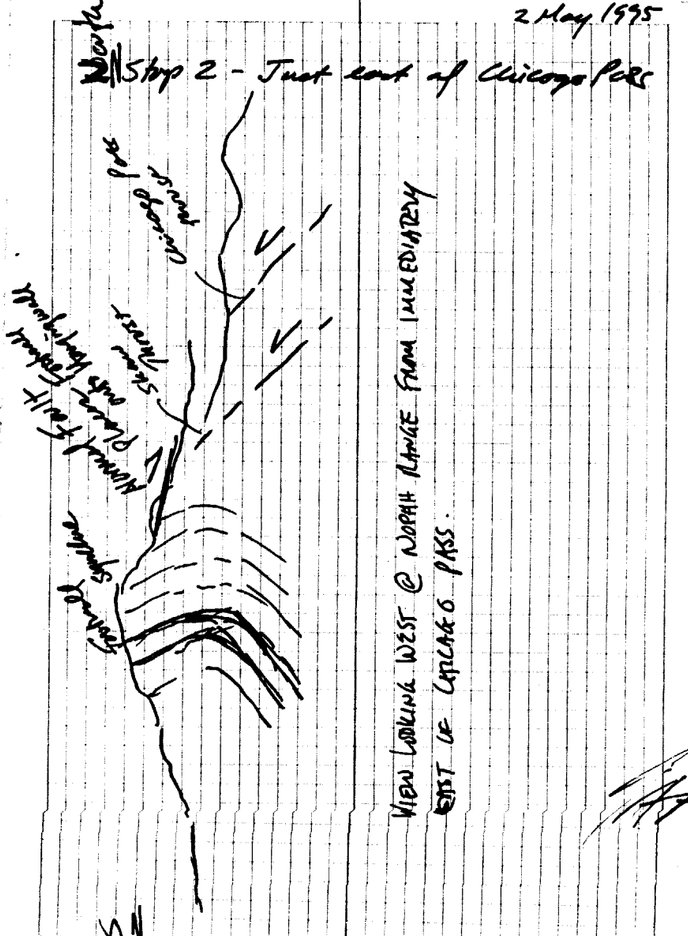
2 May 1995

Stop 2 - Just east of Chicago Pass

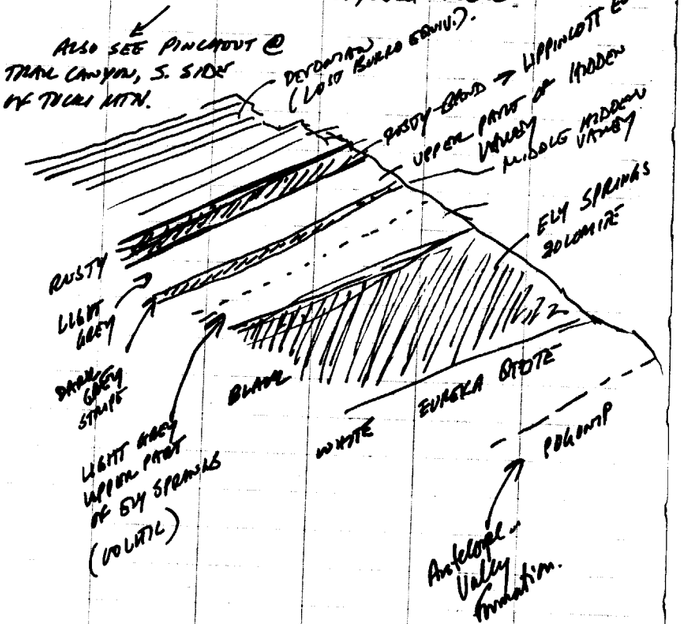


48

2 MAY 1995

STOP 3 – Chicago Pass.

Pinchout of Silurian Section to south is exposed here.



VIEW LOOKING SOUTH AT NOPAH RANGE FROM CHICAGO PASS.

49

2 MAY 1995

STOP 4 – CHICAGO VALLEY BEDS.

INTERLAYERED CONGLOMERATE, SANDSTONE & MUDSTONE BEDS DIPPING @ CA. 60 – 20°

CONGLOMERATE BEDS CONTAIN METER-SCALE BOULDERS OF HUNTER MTN. (~130 km AWAY). ALSO, FUSULINID-BEARING PERMIAN LIMESTONE AND CONTACT-METAMORPHOSED ROCKS. WERNICKE INTERPRETS THAT THIS MATERIAL WAS DEPOSITED PROXIMALLY TO HUNTER MTN. IN ALLUVIAL FANS.

- UNPUBLISHED DATE (ARGON LASER FUSION) FROM OVERLYING TUFF @ 15 Ma. (MAYBE 15.7 ACCORDING TO ZERE SNOW).

→ ZERE SAYS MAY BE TUFF OF UNCONFORMITY HILL.

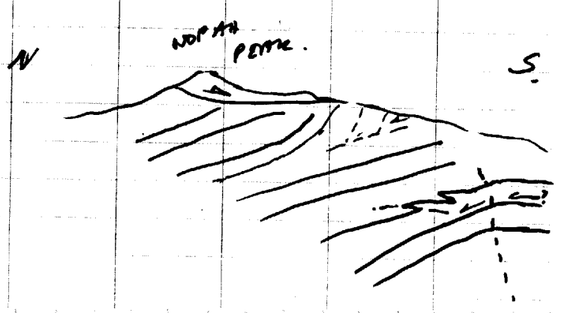
- BOULDERS IN CONGLOMERATIC BEDS VARY QUITE A BIT AN MAFIC MINERAL CONTENT.

50

2 MAY 1995.

- INTERPRETED DEBRIS FLOWS. MATRIX-SUPPORTED BOULDER CONGLOMERATES.
- WE'LL CALL THIS STOP "ZERE'S WATERLOO" IN REFERENCE TO HIS CRUCIFICATION AT THIS SPOT IN APRIL 1995 ON THE FIELD TRIP W/ LAUREN WRIGHT & OTHERS.

STOP 5 – VIEW LOOKING E OR SE @ NOPAH PEAK. NOPAH FAULT IS NORMAL FAULT AT BASE OF TIP OF PEAK



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2 MAY '95.

STOP 6 – AMARGOSA CHAOS

BASEMENT ROCK OVERLAIN BY METASED'S. ALL EXTENSIVELY BRITTLELY DEFORMED.
– UGLY ROCK.

STOP 7 – OVERVIEW OF MORMON PT. TURTLEBACK.

SPENDING NIGHT @ BURRO, INN, BEATTY, NV.

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3 MAY '95.

FIELD WORK IN DEATH VALLEY AREA.

PARTICIPANTS.
D.A. FERRILL
J. STAMATAKOS
J.K. SNOW.

STOP 1 - BOUNDARY CANYON DETACHMENT ~~[illegible]~~ WEST OF DAYLIGHT PASS (BETWEEN BEATTY & FURNACE CR.). (UPPER SPLAY OF BOUNDARY CANYON DETACHMENT).

pЄ JOHNNIE FM. ON FOOTWALL OF BOUNDARY CANYON DETACHMENT.

METASEDIMENTARY ROCKS THAT HAVE WELL DEVELOPED DUCTILE FABRICS THAT HAVE BEEN OVERPRINTED BY BRITTLE DEFORMATION.
ROCK TYPES INCLUDE: F.G. MARBLE, META DOLOSTONE, QUARTZITE, META PELITES.

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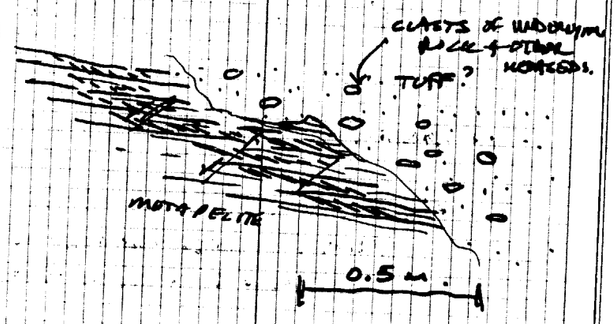
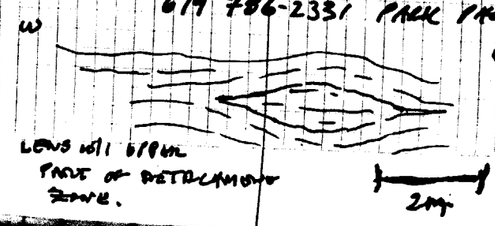
3 MAY '95.

LENTICULAR FABRIC W/ METER + SCALE LENSES. CLEAVAGE @ U. LOW ANGLE TO LAYERING IN METAPELITE.



- STERLING QUARTZITE IN DETACHMENT
- WOOD CANYON (INTACT) ABOVE.

RESOURCE MANAGEMENT OFFICE
DICK ANDERSON - @ LOW CREEK.
619 786-2331 PARK PHONE #.



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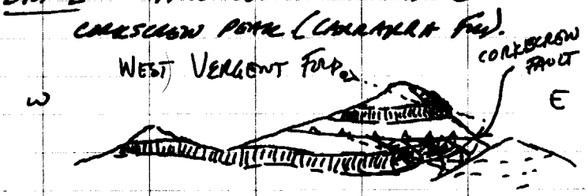
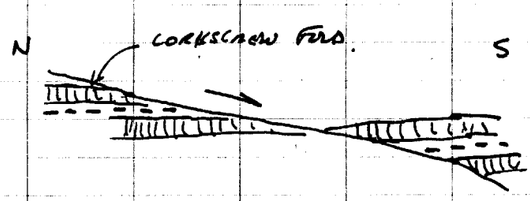
3 MAY '95

STOP 2 - VIEW LOOKING NORTH @ CORKSCREW PEAK (CARRARRA FM).



- HANGINGWALL OF BOUNDARY CANYON DETACHMENT
- FOOTWALL OF TITUS CANYON FAULT (POTENTIALLY LARGE-DISPLACEMENT LOW ANGLE DETACHMENT FAULT).



ZERE INTERPRETS THESE FAULT AGES.

BOUNDARY CANYON DETACHMENT ≈ 6-8 Ma.
(APATITE FISSION TRACKS. DOKKA & HOLME '91?).
TITUS CANYON FAULT - MAYBE b/w 34 Ma & 36 Ma.
ZERE THINKS MAY HAVE STRIPPED STRIPED HILLS OF GRAPEVINES

55

3 MAY 95.

STOP 3 - OVERVIEW OF COTTONWOOD MTNS. AND TUCKI MTN FROM PULLOFF NEAR TURN N. TOWARD STONE PIPE WELLS.

STOP 4 - TRACE OF FURNACE CR. FAULT IN ALLUVIUM NEAR BASE OF TITUS CANYON ALLUVIAL FAN (EAST SIDE DOWN ~1-2 m).

STOP 5 - WEST VERGENT ANTICLINE AND SYNCLINE VISIBLE NEAR AND SOUTH OF MOUNT PALMER (MT. PALMER THRUST).

STOP 6 - VIEW OF COTTONWOOD MTNS. DRY BONE SYNCLINE, DRY BONE FAULT, DRY BONE STOCK.

- DRY BONE SYNCLINE IS EAST VERGENT.

IBC FIELD TRIP T138 STOP 7-1
(WERNICKE et al. 1989)

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3 May '95.

STOP 7 - Alluvial fan west of Stovepipe Wells -

- Hunter Mtn. boulders in fan ~ 10 km from Hunter Mtn.

→ For comparison w/ Chicago Valley BSDS.

STOP 8 - Petroglyphs on outcrop of ~~Mineral Ridge~~ Mesquite Spring Tuff (≈3 Ma) (2.1-3.2 Ma) Tuff) on road to Aguereberry Point.

STOP 9 - Aguereberry Pt., Panamint Mountains.

All major blocks of Death Valley region visible here.

e.g. Cottonwoods, Tucki Mtn., Grapevines, Funerals, Blacks, Bare Mtn., Spring Mtns.

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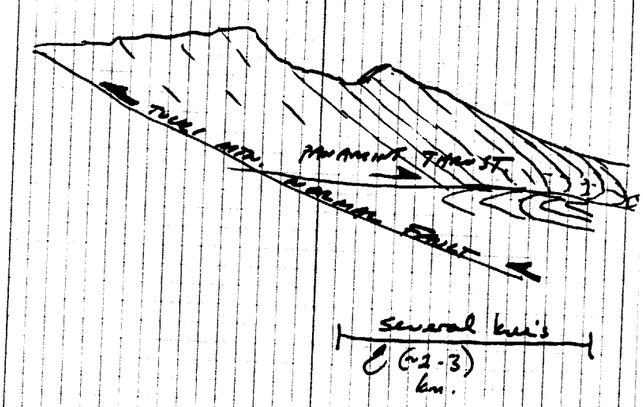
3 May '95

View looking N at east flank of Tucki Mtn.



Wernicke et al 1989 IGC Field Trip Guide Stop # 6-3.

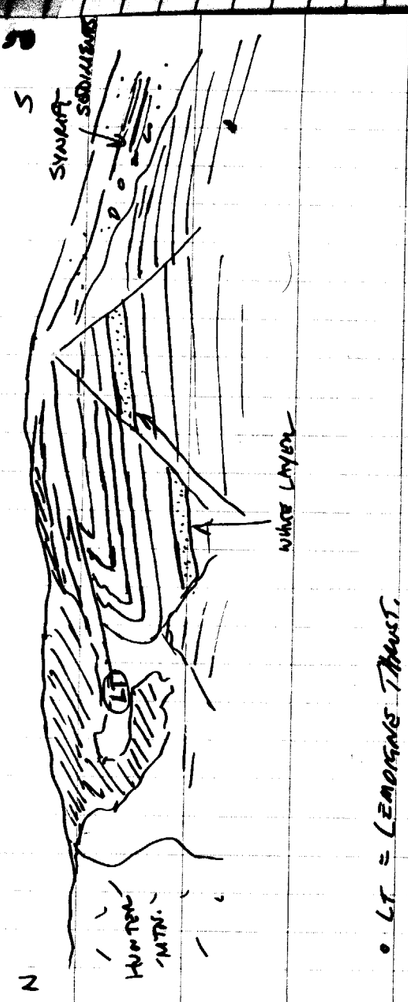
STOP 10 - Father Crowley Overlook - Darwin Plateau @ Rainbow Canyon

Wernicke et al 1989 Stop # 6-

58

3 May '95.

View looking east at south end of Cottonwood Range.



• LT = Lemoigne Thrust.

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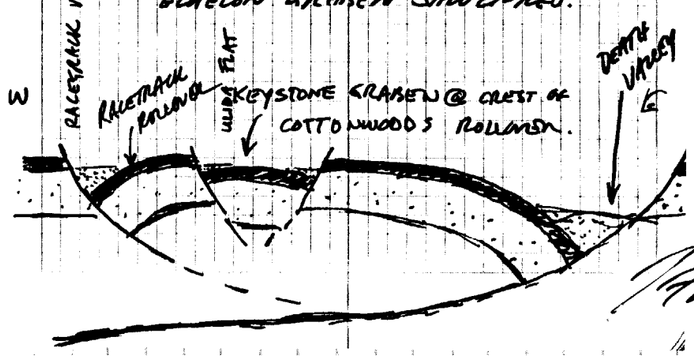
4 May 1995

Cottonwood Mtns. w/ Zeke Snow & John Stamatakos

Drove from Beatty, NV through Death Valley, Townes Pass, Panamint Valley, Darwin Plateau, Hunter Mtn.

STOP 1 - Overview from South End Ulida Flat. Discussion of regional structure.

Ubehebe Klippe (piece of last chance Allochthon), Racetrack Dupley Zone, White Top Backfold, Lost Burro Gap Crocline, and en echelon Graben structures.



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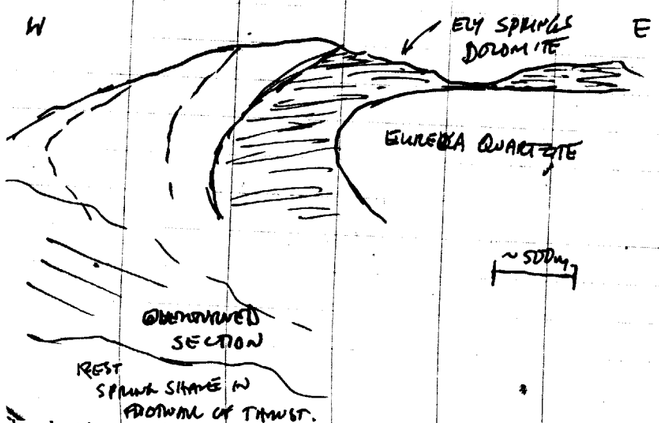
4 May '95

STOP 2 - NORTH PART OF HIDDEN VALLEY.
VIEW OF NORTH END OF VALLEY.
(JUST SOUTH OF LOST BURRO GAP).
- RACETRACK DUPLEX CUT BY NORMAL FAULTS (WEST DIPPING).

- LOST BURRO MTN.

→ NOTED PENCIL CLEAVAGE IN REST SPRING SHALE EN ROUTE TO STOP 3.

STOP 3 - WHITE TOP BACKFORD.



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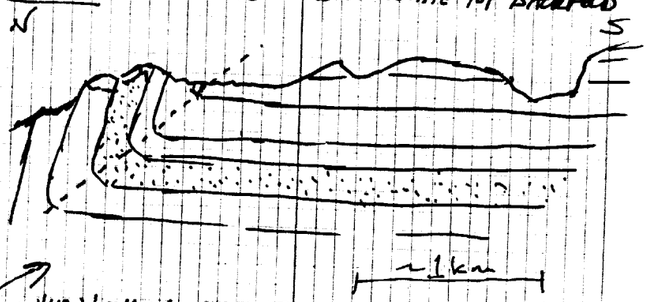
4 May '95.

WERNICKE et al. (1989) IGC FIELD GUIDE STOP

STOP 4 - OVERTURNED LIMB OF WHITE TOP BACKFORD



VIEW LOOKING EAST TOWARD DEATH VALLEY.

1988	GSA Abstract (Cordilleran)	Snow & Wern.
1988	Field Trip (Cordilleran)	Wernicke et al.
1989	GSA Bulletin	Snow & Wernicke
1989	IGC Field trip Guide	Wernicke, Snow et al
1990	Thesis	Snow
1991	PERMOTRIASSIC PLUTONISM GEOLOGY	Snow et al.
1992	GSA Bulletin - Large Mag Perm Prof	Snow
1990	GSA Mem. -	Snow & White

- AH, JUST SEE ZEKE'S CV FOR LIST OF PUB'S ON COTTONWOODS.

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4 May '95.

STOP 5 - THRUST IN FORELIMB OF WHITE TOP BACKFORD. DEVONIAN CARBONATE ON TOP OF MISSISSIPPIAN SHALE.
MISSISSIPPIAN SHALE IN FOOTWALL SHOWS UPWARD TRANSITION FROM UNCLEAVED BLACK SHALE WITH VERY STRONG BEDDING FISSILITY TO PENCIL CLEAVAGE WITHIN 1-2 m OF THRUST FAULT. TRANSITION OCCURS WITHIN ~25-50 m OF THRUST IN FOOTWALL.
↑ PROBABLY CLOSER TO 25 m.

↑ MISSISSIPPIAN REST SPRING SHALE.

STOP 6 - LOST BURRO GAP.

NEAR RACETRACK VALLEY -
VERY STRONG EVIDENCE FOR UPLIMB SHEAR!

THIS IS IN CONTRAST TO EVIDENCE OF DOWN-DIP SHEAR SEEN HERE IN OCTOBER DURING GPS CAMPAIGN. (FURTHER EAST IN CANYON).

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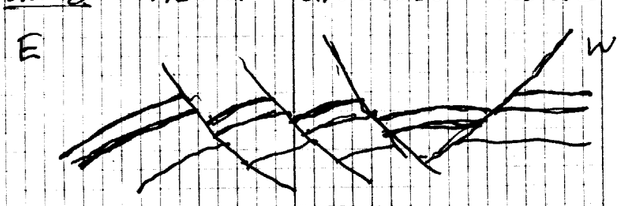
4 May '95.

* SHOULD COME BACK AND CHECK OUT FOR LAYER-PARALLEL SHEAR MODELS.
↳ SHEAR RELATIONSHIPS HERE SEEM AMBIGUOUS. PROBABLY B/C COMBINATION OF COMPRESSIONAL UPLIMB AND EXTENSIONAL DOWNLIMB SHEAR.

STOP 7 - TIN PASS.
LANDSLIDE DEPOSITS. MAY BE GOOD PLACE TO TEST OUT PALEOWAR APPROACH TO DATING LANDSLIDES - SUGGESTED BY JOHN STAMATAKOS.

STOP 8 - VIEW OF COTTONWOODS ROLLOVER



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4 May '95.

1992 GSA Bulletin Paper - Snow
→ Discusses Duplex Zone in Footwall of Last Chance Thrust
→ Wickleman Peak Thrust Fault

1994 Casamani Trexler & others
GSA Cordilleran Section Guide.
→ Say that Chainman & Eleana in Mine Mtn Area are equivalent -
Duplex Interpretation
→ Go back to USGS map.
W. Yucca Flat.
(Zerle has Ref's.)
Mine Mtn. Quad.
CP Hills Quad.

65
4 May '95

Zerle suggest that we look @ strat./structure in North End of Grapevines for comparison w/ Bare Mtn. There is a decent M.S. thesis on area. See J.K. Snow for reference.
* Palmer & Haley 1979 Carrara.
U.S.G.S. Professional P. 1047

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5 May 1995

Overflight of Death Valley - Owens Valley Region

Overfight in Cesna 210 chartered from Associated Jet Charter, Las Vegas, Nevada.

Associated Jet Charter - Jim Jakus
Tel: (702) 798-4610
Fax: (702) 798-2874
(800) 222-9993.

Persons present:
Ross Truesdale - Pilot, Assoc. Jet Charter
David Ferrill - CNWRA
John Stamatakos - U. Michigan
J. Kent Snow - Caltech

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5 May '95

Overfight left from Las Vegas and included following locations (in order)

North Spring Mtn. Turtleback
Montgomery Mtns
Stewart Valley Fault (not very clear from air)
Chicago Pass
Chicago Valley Beds
South Funeral Range
Furnace Creek Fault
Extension Fractures in Tertiary Gravels.
→ Landed at Furnace Cr. for restroom break
Furnace Creek Fault Zone.
Cottonwood Mtns. -
Dry Bone Stock
Dry Bone Syncline
Marble Canyon Thrust
- Footwall Syncline
- Hangingwall Anticline
Southern Cottonwoods Basins
- Racetrack Valley
- Ulida Flat
Lost Burro Gap (Thrust Fault).

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5 May '95

SALINE VALLEY
SALINE RANGE
- FAULTED 3 Ma BASALT
- BASALTIC DIKE INTRUDING FAULT
▷ LONE PINE - (LANDED FOR FUEL)
SALINE RANGE - MORE FAULTED 3 Ma BAS.
LAST CHANCE RANGE
N. COTTONWOODS (ROLLOVER).
UBEHEBE CRATER.
PANAMINT RANGE
- TUCKI MTN. DETACHMENT
- DINO BASALT (7-8 Ma?)
- BASALTIC DIKES INTRUDING LISTRIC NORMAL FAULTS.
▷ FURNACE CREEK (LUNCH STOP).
GRAPEVINE RANGE
- CORKSCREW SYNCLINE
- "BAULFOLD"
- TITUS CANYON DETACHMENT.
BULLFROG MINE
BARE MTN.
- FAULTED TUFFS @ N. END.
- BARE MTN. FAULT (TRENCHES)

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5 May '95.

- PANAMA THRUST & FOOTWALL SYNCLINE
- NORMAL FAULT BLOCKS

CRATER FLAT VALLEY
LATHROP WELLS CONE
NE FLANK OF SPRING MTNS.
LANDED IN LAS VEGAS.

6.2 HOURS TOTAL FLYING TIME.
FLIGHT BEGAN @ ~ 8:00 A.M.
FLIGHT ENDED @ ~ 4:30 P.M.
→ VERY BUMPY -
J. STAMATAKOS SOMEWHAT ILL FEELING.

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17 May 1995

DOE/NRC SITE VISIT.
YUCCA MTN. NEVADA.
17-18 May 1995

SPENT NIGHT OF 16 May IN INDIAN SPRINGS, NV.

7:00 A.M. MEET @ MERCURY GATE.
(BADGED AT DOE HIGHLAND ROAD OFFICE, LAS VEGAS, ON 16 May '95)

8:00 A.M. MEETING BEGINS @ 8 AM @ YM PROJECT OFFICE.

INTRODUCTION BY TOM BJERSTEDT & MARK TWAN.

~8:30 A.M. STEVE BEASON
ESF MAPPING.
- FRACTURE MAPPING.
DETAILED LINE SURVEYS.
- LAY OUT TAPE, MEASURE ALL
- FRACTURES > 10 cm LENGTH.
- "FAULTS" HAVE DISPLACEMENT > 10 cm
- "SHEARS" HAVE DISPLACEMENT < 10 cm.

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17 May '95.

CURRENT POSITION OF TBM @ 7+62.

- RIGHT WALL SPRING LINE = HALF WAY UP RIGHT WALL.
- BOW RIDGE FAULT ON RIGHT WALL ≅ 2 m. A LITTLE BIT THICKER IN CROWN. FILLED w/ "FAULT RUBBLE".
- TUFF CONTACTS WELL EXPOSED IN TUNNEL.
- FAULTS w/ DISPLACEMENTS ~ > ½ m ARE SHOWN ON CROSS SECTION. THERE ARE MANY SMALLER-DISPLACEMENT FAULTS "GOING BOTH WAYS."
- MAPPED 28 FAULTS (>10 cm DISPLACEMENT) ON RIGHT WALL.
- FAULTS IN WELDEDED UNITS TEND TO BE THIN.
- EVIDENCE OF STRIKE SLIP COMPONENT "LOW-ANGLE SLICKENSITES."
- NOT MANY NE TRENDING FAULTS. TEND TO SEE NW TRENDING FAULTS!?
- OPAL FRACTURE FILLINGS FAIRLY COMMON.
- FRACTURE APERTURES SOMETIMES QUITE LARGE. 4,5 → 8 cm
- TEND TO CHANGE APERTURE OVER SHORT DISTANCE (DISCONTINUOUS).

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17 May 1995.

- "SPOTTY" CALCITE FRACTURE FILLINGS SUGGEST TURTLING FLUID PATHWAYS.
- V. FEW FRACTURES W/ ~ CONTINUOUS FRACTURE FILLINGS.

→ WATER IN TUNNEL. MAY BE NATURAL OR INTRODUCED.

- MOIST CLAY IN FRACTURE EAST OF BOWRIDGE FAULT.
- MOISTURE @ ~ 5+3 @ ("HIGHLY DISTURBED") → PROBABLY INTRODUCED

FIELD TRIP TO UZ7a DRILL PAD – DISCUSSION OF GHOST DANCE FAULT.

- RICK SPENGLER DISCUSSES 1:240 MAPPING OF GHOST DANCE FAULT IN AREA.
- PHOTOS OF GHOST DANCE SCARP AT UZ7a DRILL PAD EXPOSURE. SCARP 1-2m HIGH AT THIS SPOT. EXCAVATED EXPOSURE OF HEAVILY FRACTURED ROCK > 20m.
- SEVERAL OTHER NORTH-SOUTH TRENDING FAULTS HAVE BEEN MAPPED IN THIS AREA.

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17 May 1995.

- PREEXISTING COOLING JOINT FABRICS
  NW, NE → TRENDING COOLING JOINT TRENDS.
  → DEFORMATION MAY HAVE CAUSED REACTIVATION OF COOLING JOINTS.

WARREN DAY – U.S.G.S. DISCUSSED.

- 1:6000 MAPPING OF AREA.

ERNIE MAJER

- DISCUSSED ~~SHOOTING~~ DAF SEISMIC LINES ACROSS THE GHOST DANCE FAULT AT THIS LOCATION ALONG DRILL PAD. (FOUR LINES)
  - HAMMER & PLATE SOURCE – SEE FAULT TO 2500'.
  - OTHER SEISMIC SHOT USING IMPACT SOURCE AND 12m SPACING.
  - REFLECTORS MORE CONTINUOUS BELOW WATER TABLE.
  - VELOCITY PULL DOWN MAY BE RELATED TO FRACTURING ASSOCIATED W/ GHOST DANCE FAULT.

SHERYLYN WILLIAMS-STROUD

DISCUSSION OF SKETCH MAP OF STRUCTURES IN TIVA CANYON TUFF EXPOSED AT UZ7A DRILL PAD.

MAPPING SUGGESTS 60-70' DISPLACEMENT

CRYSTAL RICH VS CRYSTAL ROCK BOUNDARY IS OFFSET.

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17 May '95.

DISLACEMENT CHANGES ACROSS RIDGES TO NORTH

60-70' S
90'
45'
—
↓ N

SECONDARY FAULT HAS 2-3 m DISPLACEMENT.

HIKED UP WHALE BACK RIDGE FROM UZ7a DRILL PAD.

RICK SPENGLER

→ THERE APPARENTLY IS REMAINING UNCERTAINTY REGARDING THE RELATIONSHIP BETWEEN GHOST DANCE AND SUNDANCE FAULTS.
→ SPENGLERS INTERPRETATIONS HAVE NOT CHANGED IN 1 YR.

EMILY TAYLOR

- TRENCH ~~[illegible]~~ GHOST DANCE FAULT @ CREST OF WHALE BACK RIDGE.
  - DATED COLLUVIUM USING URANIUM SERIES DATING → MIN AGE FOR COLLUVIUM ⇒ 80-90,000 yrs.
  → VERY CONFIDENT THAT THIS LAYER IS UNCUT BY FAULT.

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17 May '95.

R. SPENGLER – GHOST DANCE FAULT MAY BE OFFSET RIGHT LATERALLY BY ABOUT 45' BY A FAULT SUBPARALLEL? TO GHOST DANCE FAULT.

DAVE GUESCH – DISCUSSION OF STRATIGRAPHY HERE.

WARREN DAY

WIDTH OF GHOST DANCE FAULT ZONE IS ~250' HERE! EAST & WEST BOUNDARIES VISIBLE HERE @ CREST OF WHALE BACK RIDGE.

QUESTIONS/DISCUSSION REGARDING OTHER ARGUMENTS TO MAKE REGARDING DATING OF FAULT OFFSET USE TUFF STRATIGRAPHY & EROSION.

- MATERIAL SEEN IN FAULT NOT FOUND UPDIP. NO SOURCE
- SOME UNITS ~ EXCLUSIVELY REMAIN PRESERVED IN DROPPED DOWN HANGINGWALL BLOCKS. SUGGESTS THAT DISPLACEMENT ~ QUITE OLD.

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17 MAY 1995

ELAYER - (MK/M90)

DISCUSSION OF CONTROLS ON REPOSITORY AREA & VOLUME & AREAL CONSTRAINTS:
- SET BACK FROM GHOST DANCE AND SUNDANCE FAULT.
- MIN. DEPTH REQUIREMENT
- SET BACK FROM SURFACE DRAIN ALONG SOUTHERN CANYON.
- WATER TABLE.

DAVE KESSEL (SNL).
- CORE LOGGING PROCEDURES.
- DATA HANDLING VIA COMPUTER PROGRAM
  ↳ EXCEL, CORAL DRAW

TOM BROCHER - U.S.G.S. MENLO PARK
- PRELIMINARY USGS REFLECTION SEISMIC.

BROCHER BACKGROUND:
- 1980 GRADUATE OF PRINCETON.
- 16 PEER REVIEWED JOURNAL ARTICLES
- SERVED AS ASSOCIATE EDITOR FOR JGR

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17 MAY 1995

ACQUISITION - NORTHERN GEOPHYS.
DRILLING - BUREAU OF REC.
PROCESSING - TEXCO ?

VIBROSEIS. → DAT (12 km data)
EXPLOSIVE SURFACE EXPLOSIONS (6 km data)
SURFACE EXPLOSION
DEEP HOLES (3200')

→ TESTED SOURCE AND RECEIVER ARRAYS.
* 4 VIBROSEIS TRUCKS.
* RECEIVER SPREAD.

I/O SYSTEM II RECORDING SYSTEM
PERTON VIBRATION SENSORS

→ "STATE OF THE ART TECHNOLOGY"

→ VICKI LANGENHEIM @ USGS HAS MODELED GEOMETRY OF GHOST DANCE FAULT (& CRATER FLAT) USING GRAVITY.

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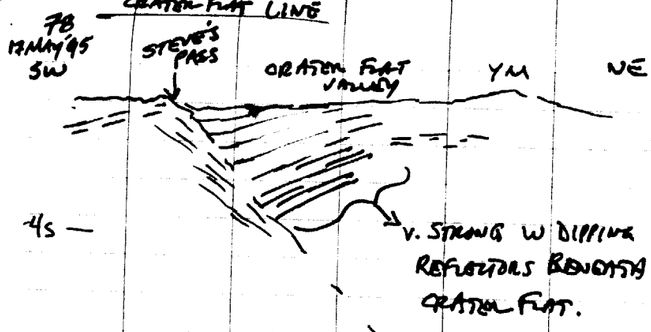
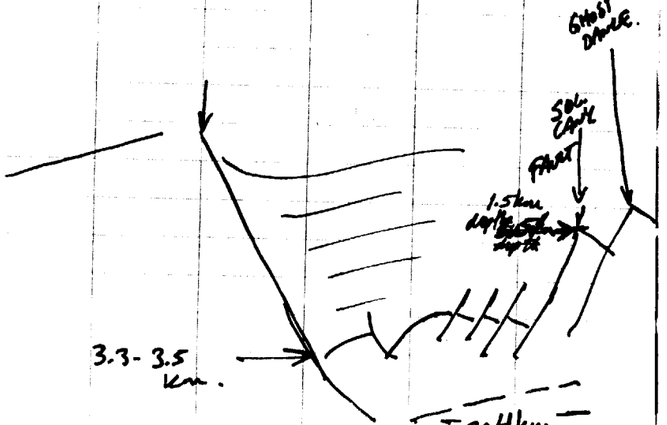
17 MAY 95
SW





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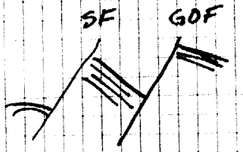
17 MAY 1995.

→ SAYS THAT GHOST DANCE FAULT MAY HAVE 1-2km DISPLACEMENT AT DEPTH.

→ MOHO @ 9-10 SECONDS.

→ FINAL REPORT DUE IN OCTOBER.



INTERPRETATION OF LINE ACROSS YM.

E. MAJER - LBL

PRELIMINARY RESULTS OF LBL HIGH RESOLUTION, STATION SEISMIC STUDIES @ YM.

WALLEN DAY

DISCUSSED STATUS OF AND PLANS FOR MAPPING.

EMILY TAYLOR

DISCUSSED GHOST DANCE TRENCHING.

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17 MAY '95.

MARK TYNAN (DOE)

CONSOLIDATED 3D MODEL EFFORT.
(VERY BRIEF).

DAVID JEFFRIES (EG&G)
↳ (O&G DEVELOPMENT BACKGROUND)
GEOLOGIC FRAMEWORK & INTEGRATED
3D SITE-MODEL PROCESS.

MOSAIC HOME PAGE
POSC EPICENTER DATA MODEL

→
MY PRESENTATION ON FINITE ELEMENT MODELING OF LISBON WASH FAULTING WAS QUITE WELL RECEIVED. ALSO, SLIP TENDENCY PLOTTERS V. WELL RECEIVED.
* WARREN DAY (USGS) GAVE CARD TO ME AND REQUESTED THAT I SEND WHAT I CAN ON SLIP TENDENCY ANALYSIS (E.G. SEMIANNUAL REPORTS).

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18 MAY 1995

DAY 2 OF DOE/NRC SITE VISIT.

STOP 1 - DENNIS OLEARY (USGS).
ROCK VALLEY -
- SITE OF ONGOING SEISMIC ACTIVITY -
- INCLUDES LITTLE SKULL MTN. QUAKE IN PATTERN.
- 18+ km LENGTH OF LEFT LATERAL STRIKE SLIP FAULT.
CROOK VALLEY IS TENSIONAL FEATURE.
- LATE PLEISTOCENE ALLUVIUM FANS.
- TRENCH RV-4.
↳ SITED BASED ON AERIAL PHOTOS. LINEAMENTS DEFINED BY CREOSOTE BUSHES. TRENCHES LOCATED BY DENNIS OLEARY & CHRIS MENGES.

RV4 - MAIN TRENCH

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18 MAY '95

LAST YEAR, JIM BRUN REPORTED 3-4 <M2 EARTHQUAKES JUST NORTH OF HERE ON "MEDIAL STRAND" OF ROCK VALLEY FAULT (PREVIOUSLY TRENCHED BY LOCK CAGE & LOGGED BY JIM YOUNT). EARTHQUAKE HYPOCENTERS @ DEPTHS < 2km.

JIM YOUNT DISCUSSES TRENCH LOGGED AT TRENCH RV-4.

* SLICKENLINES RAKE ~10° WHERE THIS FAULT EXTENDS INTO BEDROCK.

~10 cm VERTICAL OFFSET SEEN HERE. ESTIMATE OF ca. 1m IF ASSUME 10° RAKE FOR DISPLACEMENT DIRECTION..
* I WOULD GUESS THAT RAKE ASSUMPTION IS A MAJOR SOURCE OF UNCERTAINTY B/C IT IS UNLIKELY TO CHANGE DRAMATICALLY

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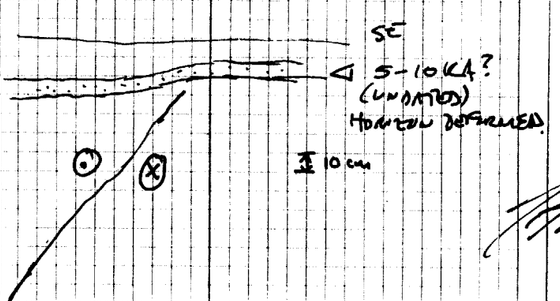
18 MAY '95.

WITH CHANGES IN FAULT PLANE ORIENTATION

- EVIDENCE OF HOLOCENE OR LATE PLEISTOCENE. MAY NOT HAVE BEEN A MAJOR EVENT. BUT - SURFACE LINEAMENT EXTENDS FOR ~ 8km.
- NO HARD EVIDENCE OF MORE THAN 1 EVENT IN RV-4 TRENCH. BUT, ~3 EVENTS SEEN IN OTHER TRENCHES.
- ~ UNIT 4 (SOIL HORIZON) SEEN HERE LOOK LIKE 40-100 KA SOIL MAPPED AROUND THIS REGION. THIS SOIL HORIZON IS CLEARLY BROKEN IN THIS TRENCH.

FAULT PLANE SUGGESTS MAY HAVE BEEN MORE THAN 1 SURFACE EVENT. ("GUT FEELING").



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18 MAY 1995

RV4 - TEST PIT 2.

JIM YOUNT

→ CLEAR THAT FAULTING AT AND FRACTURES CUT LAYERED ALLUVIUM, CALCRETE, ETC...

→ YOUNTS GUT FEELING IS THAT THESE WELL CEMENTED UNIT ARE CA. 250KA.

TRENCH RV-3 - NORTH STRAND OF ROCK VALLEY FAULT

JIM YOUNT

- ~1M VERTICAL OFFSET -
- HORIZONTAL OFFSET UNKNOWN.
- WEAK CORRELATION OF BOULDER BED MAY SUGGEST 3M LEFT LATERAL SLIP.
- UNIT, BASED ON SOIL CORRELATION,

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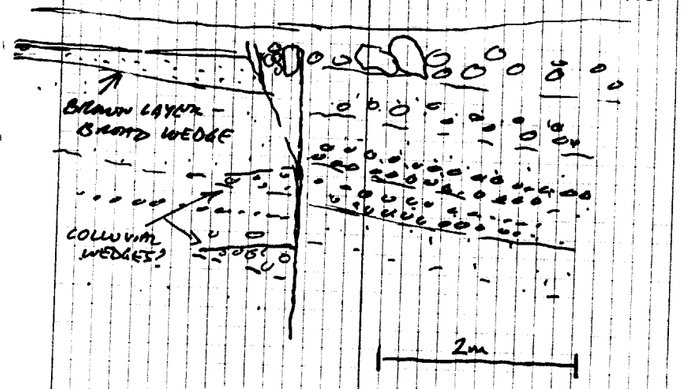
18 MAY '95.

MAY BE ~~OFF~~ D.A.F. 100+ KA.



PHOTO'S OF FAULT IN TRENCH WALL, BOTH NORMAL TO TRENCH FACE LOOKING SW AND LOOKING DIAGONALLY ALONG TRENCH.

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18 MAY 1995

FRAN RIDGE PAVEMENT

DON SWEETKIND → JUST FINISHED MAPPING FRAN RIDGE PAVEMENT.

→ WORKS IN WARREN DAY'S STRUCTURAL MAPPING GROUP.

- TOPOPAH SPRING TUFF (NEAR MIDDLE).
- RIDGELINE ABOVE PAVEMENT IS ~ TOP TO TOPOPAH SPRINGS TUFF
- UPPER LITHOPHYSAL (NEAR TOP OF NON LITHOPHYSAL ZONE).

→ 2nd PAVEMENT IN SAME UNIT WAS WORKED BY CHRIS BARTON (S. END OF FRAN RIDGE).

- OBSERVATIONS APPARENTLY NOT TRANSPORTABLE TO TIVA CANYON.

- FRACTURE INTENSITY AT S. END FRAN RIDGE MUCH GREATER THAN

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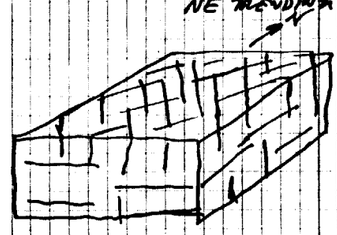
18 MAY '95.

FRACTURE INTENSITIES HERE. PROBABLY DUE TO PROXIMITY TO FAULTS @ S. END OF RIDGE.

COOLING JOINTS - TUBULAR STRUCTURES ALONG FRACTURE.
- TUBULAR STRUCTURES MAY ~~[illegible]~~ BE DUE TO SUGGEST VOLUMETRIC EXPANSION DURING COOLING.
- LONG, STRAIGHT, SMOOTH, GENTLY CURVING, CONTINUOUS EARLY (BASED ON ABUTTING RELATIONSHIPS).

NW TRENDING COOLING JOINTS
SUBHORIZONTAL COOLING JOINTS
NE TRENDING COOLING JOINTS.



LATERAL DECREASE IN INTENSITY OF NW TREND. COOLING JOINTS. ROUGH, SHORT TECTONIC JOINTS (ALSO NW TRENDING) MORE ABUNDANT WHERE COOLING JOINTS ARE LESS ABUNDANT. MAY HAVE ACCOMMODATED

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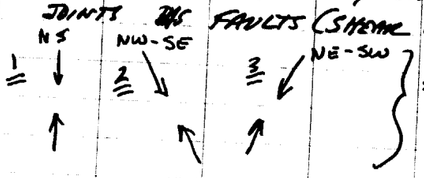
18 MAY 1995.

NE EXTENSION BY APERTURE INCREASE ON COOLING JOINTS WHERE FROSENE

- REACTIVATION OF MANY EARLY COOLING JOINTS AS FAULTS (SHEAR PLANES).



ALAN FLINT - DISCUSSES HYDROGEOLOGY WORK.
→ GEOLOGISTS & HYDROLOGISTS ARE TRYING TO WORK TOGETHER TO COMBINE INFO ON FAULTS, FRACTURES, AND STRESS TO ESTIMATE POTENTIAL EFFECTS OF FAULTS, FRAC.'s & STRESS ON GROUNDWATER FLOW.

* ASSIGN FRACTURE DENSITY INCREASE TO ZONE AROUND FAULT

- DUAL POROSITY/DUAL PERMEABILITY MODEL. NOT "DISCRETE FRACTURE"
- NOT NECESSARILY PLANNING TO USE A FRACTAL MODEL. TO BECOME A SYSTEM.

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18 MAY 95.

FRACMAN USED TO TRANSFORM DATA FROM STRUCTURAL PROGRAM TO HYDRO. PROGRAM.

MODEL - CONSISTS OF 30M x 30M BLOCKS (1m THICKNESS).
ASSIGN HYDROLOGIC PROPERTIES TO THESE BLOCKS.

LITTLE PRAIRIE - CHRIS POTTER DISCUSSES MAPPING IN LITTLE PRAIRIE AREA.

QUESTIONS: ① DOES THE SUNDANCE FAULT INTERSECT SOLITARIO CANYON FAULT (ACTIVE)?

② IF SUNDANCE & SOLITARIO FAULTS INTERSECT - WHAT IS THEIR RELATIONSHIP?

- MAPPING HAS NOT EXTENDED SUNDANCE TO YUCCA MTN. RIDGE CREST. NO EVIDENCE.
- MAPPING HAS IDENTIFIED SPLAYS NEAR SOLITARIO CANYON FAULT. DIPPING STEEPLY TO WEST.

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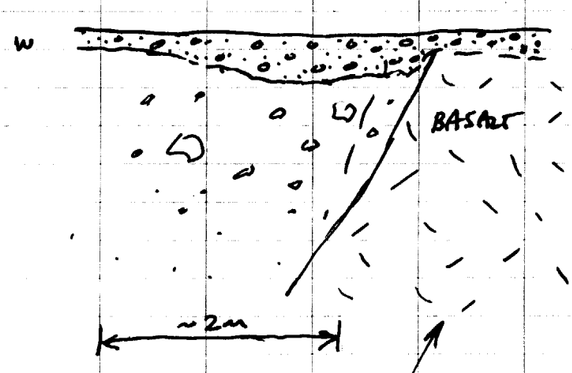
18 MAY '95

- UNLOGGED, UNNAMED TRENCH ON SOLITARIO CANYON FAULT. BRECCIATED ~10 Ma BASALT IN FAULT ZONE. ↑ NEW DATE IS 4.5 Ma

DISPLACEMENT ON SOLITARIO CANYON FAULT INCREASES TO SOUTH. SEEMS TO BE RELATIVELY SMALL HERE.



BASALT FOUND IN FAULT BRECCIA. POSTDATES SOME SLIP, BUT NOT ALL OF THE SLIP. THE BASALT

91

18 MAY

BOB SCOTT MAPPED ISOLATED OCCURRENCES OF BASALT ALONG NW TRENDING FAULT JUST NORTH OF HERE.

→ BASALT CAN BE MAPPED FOR ~100 m ALONG THE SOLITARIO CANYON FAULT
→ INTERMITTENTLY BRECCIATED AND UNBRECCIATED.

DIPPING 70-80° W

SOLITARIO CANYON DISPLACEMENT

RIDGE N OF LITTLE PRAIRIE - 400'

LITTLE PRAIRIE. 50'

BOB SCOTTS CROSS SECTION - 400 m (TO SOUTH, YUCCA CREST AREA).

* JASPEROIDAL LOOKING MATERIAL IN FAULT ZONE.

* DIKE IN FAULT DOWN SLOPE TO SOUTH OF LITTLE PRAIRIE ~30cm THICK.

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18 MAY 1995

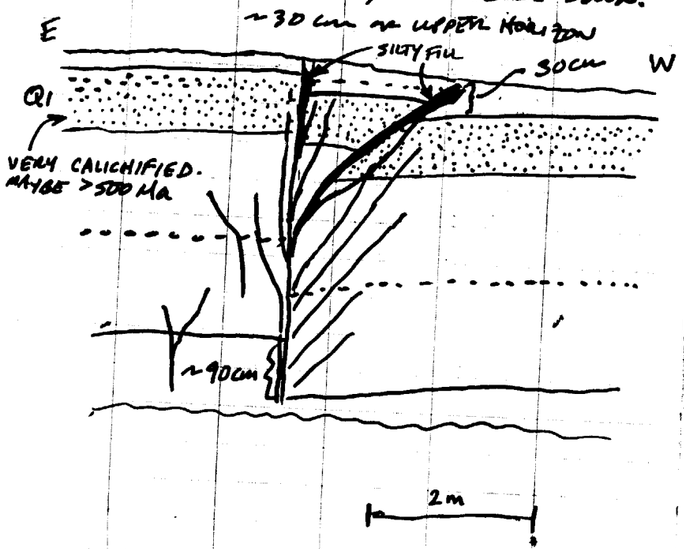
CRATER FLAT TRENCHES

JEFF COE

CFF-TZA (CRATER FLAT FAULT, TRENCH 2 AUT.)
NORTH OF BLACK CONE, ~6.5 km
WEST OF WESTERN REPOSITORY
EDGE.

→ NORTH-SOUTH STRIKING FAULT.

• VERTICAL OFFSET OF LOWER LAYER
~90 cm, WEST SIDE DOWN.
~30 cm OF UPPER HORIZON



93
18 MAY 95

STAGECOACH ROAD FAULT HAS CA. 1 ORDER OF MAGNITUDE SMALLER REOCCURRENCE THAN FAULTS HERE.

→ QUATERNARY DISPLACEMENT TENDS TO DECREASE NORTHWARD ON THESE FAULTS.

TRACE OF THIS FAULT IS CA. 12km IN LENGTH (20km IF ADD SEGMENT IN SOUTH).

• DOING U SERIES DATING ON SILICA RINDS.
• 3 EVENTS. LOW OCCURRENCE INTERVAL.

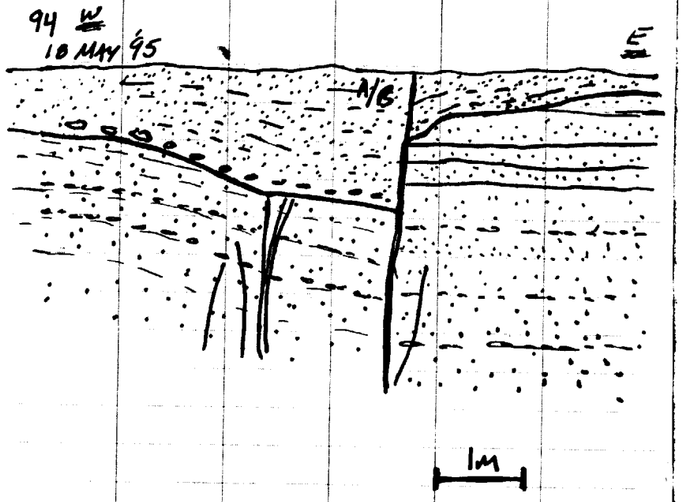
EMILY TAYLOR

CFFT 1A.

SOUTHERN CRATER FLAT.

• YOUNGEST OFFSET UNIT IS HOLOCENE.
• OTHER HOLOCENE OFFSETS SEEN IN WINDY WASH AND ROCK VALLEY.

94 W
18 MAY 95 E



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22 AUGUST 1995

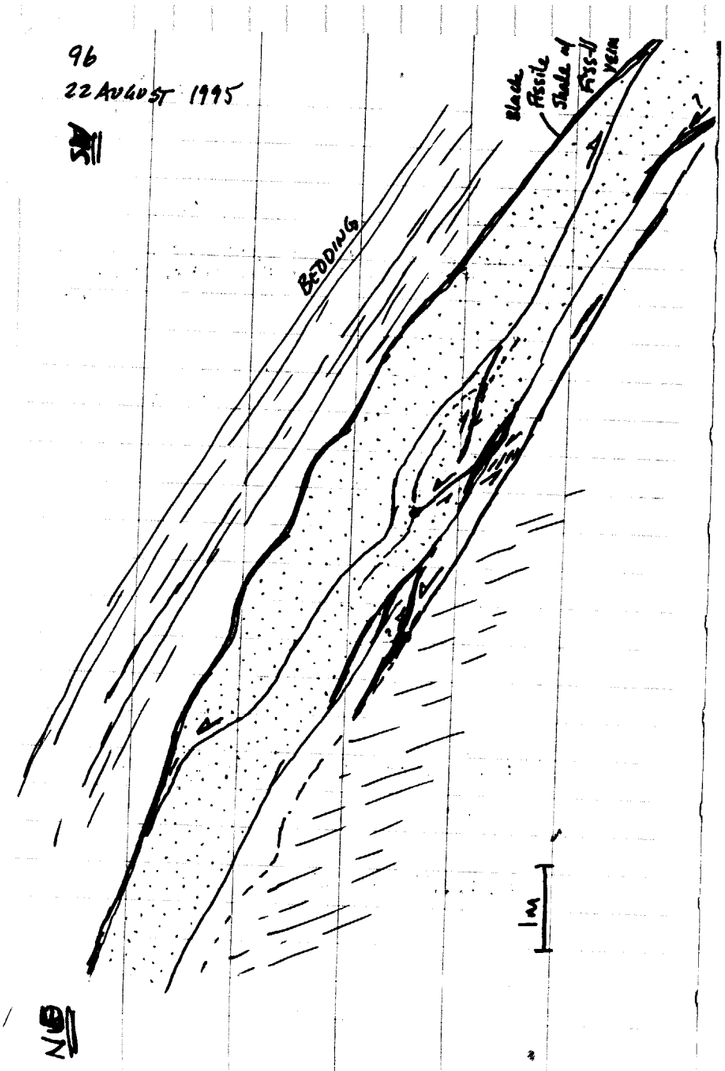
CALGARY, ALBERTA, CANADA

FLEW FROM SAN ANTONIO → SALT LAKE CITY → CALGARY FOR PANROSS CONFERENCE ON "FAULT RELATED FOLDING"

- PREMEETING INFORMAL FIELD TRIP WITH RICK GROSHONG, JOHN SPANG, AND BILL DUNNE.
- PIGEON MOUNTAIN OUTCROP, BANFF FORMATION.
  - → FIGURE 4 IN SPANG, WOLCOTT AND SERRA ABI (HAWAII VOLUME).
  - → Transcanadian Highway, SOUTH SIDE.

→ BEAUTIFUL WEATHER → CLEAR AND IN 70's.

96
22 AUGUST 1995



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23 AUGUST 95

FIELD TRIP DAY 1

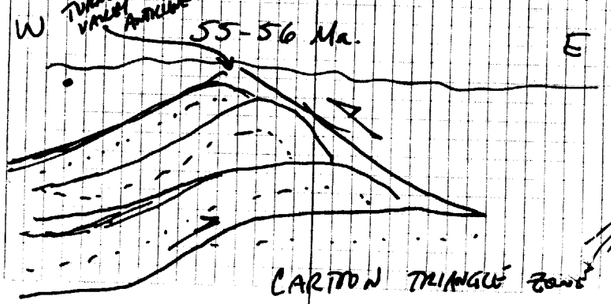
PENROSE CONFERENCE ON "FAULT-RELATED FOLDING"

LAST NIGHT (22 AUGUST 1995)
- ~30 MIN. INTRODUCTION TO CANADIAN ROCKY MTN. STRUCTURE BY RAY PRICE.

TODAY → FIELD TRIP LED BY PHILIP SIMONY & PAUL MACKAY.

"FAULT-RELATED FOLDING IN THE FOOTHILLS AND FRONT RANGES OF SOUTHERN ALBERTA"

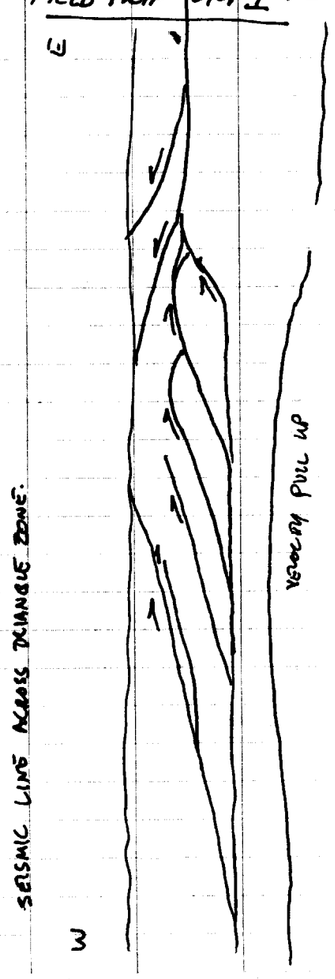
INFORMAL STOP 0.
STOP 1 LED BY PAUL MACKAY . . . → TURNER VALLEY ANT.
- DATE OF THRUSTING, FROM APATITE FISSION TRACK THERMOCHRONOMETRY.



CARTON TRIANGLE ZONE

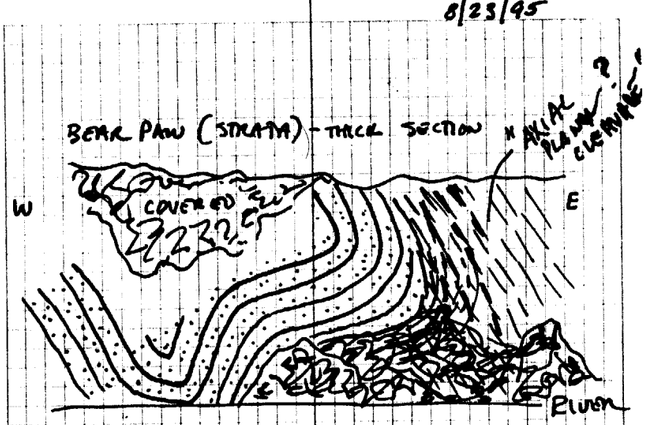
98
8/21/95

FIELD TRIP | STOP 1 - THE TURNER VALLEY STRUCTURE



3

99
8/23/95



- ASYMMETRY - LONG LIMBS & SHORT LIMBS.
- MINOR FAULTS w/ HINTERLAND VERGENCE.

RICK GROSHONG QUESTIONS: WITHOUT THESE OUTCROPS, WOULD YOU STILL INTERPRET BACKTHRUST SENSE?

STOP 2 - THE McCONNELL THRUST AT MOUNT HEAD.

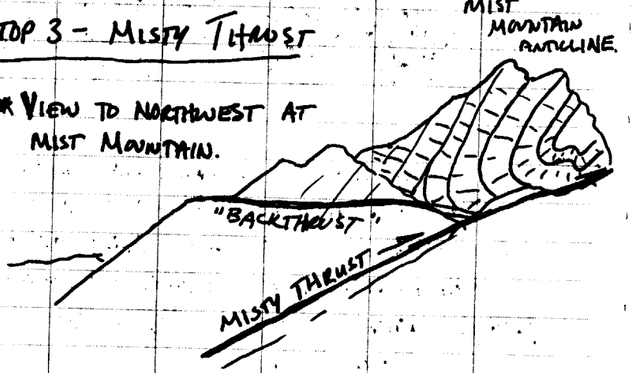
100
8/23/95

MOUNT HEAD

W E

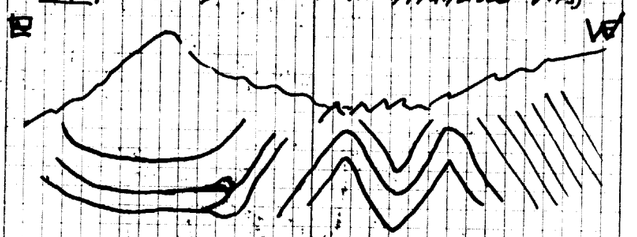
STOP 3 - MISTY THRUST

* VIEW TO NORTHWEST AT MIST MOUNTAIN.

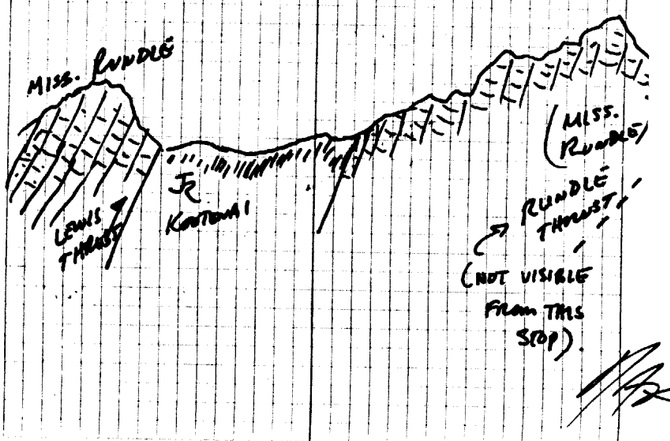


101
8/23/95.

STOP 4 - LEWIS THRUST AT HIGHWOOD PASS

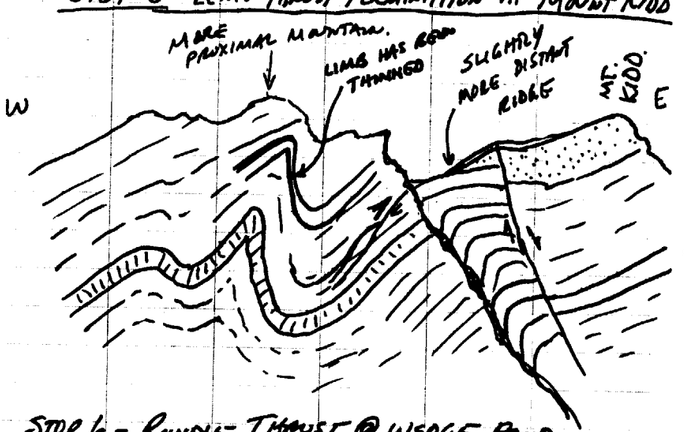


W E

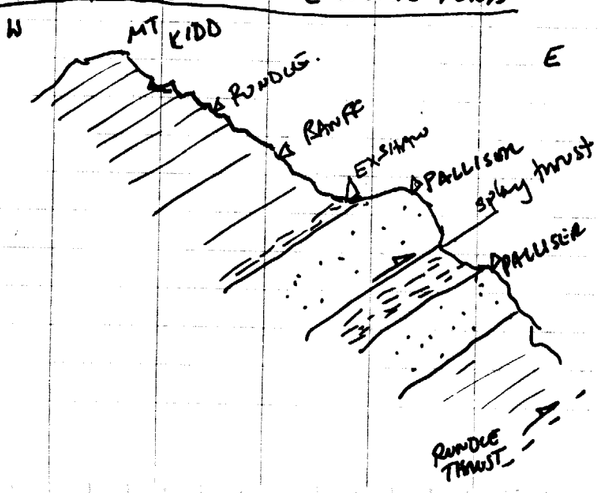


102
8/25/95

STOP 5 - LEWIS THRUST TERMINATION AT MOUNT KIDD

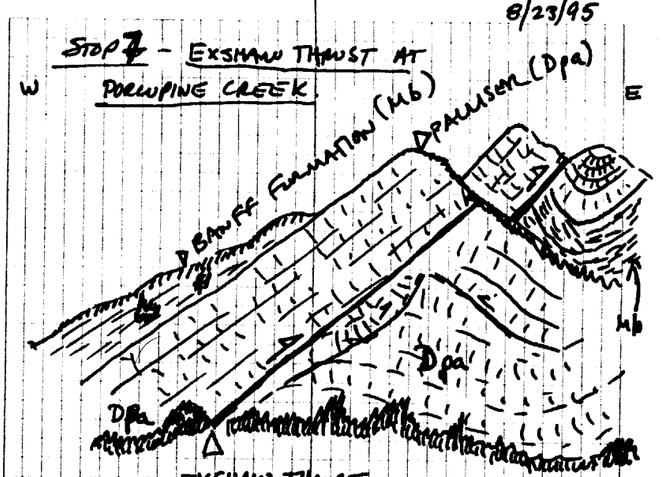


STOP 6 - RUNDLE THRUST @ WEDGIE POND



103
8/23/95

STOP 7 - EXSHAW THRUST AT PORCUPINE CREEK

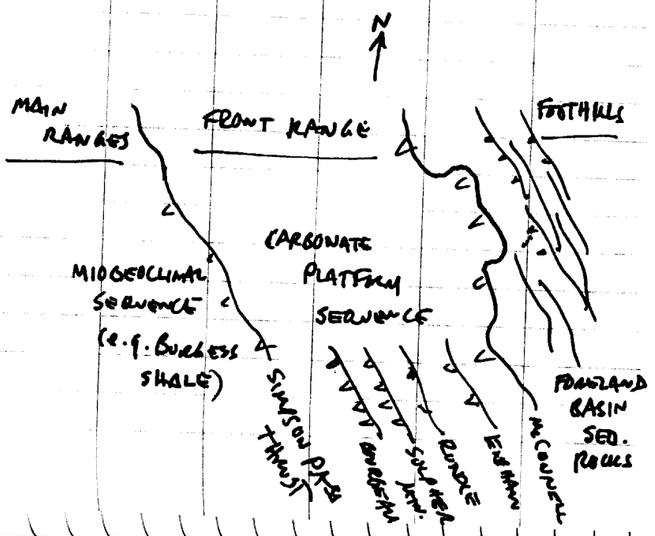


104
8/25/95

FIELD TRIP DAY 2

- LEADERS: RAY PRICE & BOBBIE SPRATT
- BANFF AT COL MORNING.
- STOPS USED HERE ARE THOSE IN THE GUIDEBOOK.

STOP 19 - VIEWPOINT OF CASTLE MTN. (PREVIOUSLY KNOWN AS MT. EISENHOWER).
→ BACK PART OF FRONT RANGES.



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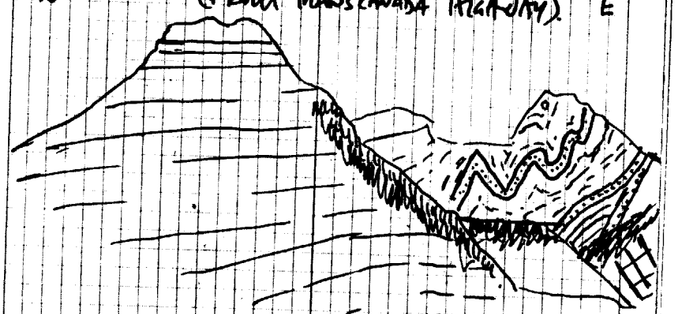
8/25/95

FOOTHILLS SOURCE ROCKS: EXSHAW & KOOTENAY.

STOP 18 - BOURGEAU THRUST IN SPRAY RANGE.

- SEVERAL CROSS-STRIKE STRIKE SLIP FAULTS EXTEND PARALLEL TO STRIKE IN THIS AREA.

INTERMEDIATE UN-NUMBERED STOP - VIEW LOOKING NORTH AT GROTTO MOUNTAIN.



SEE NEXT PAGE

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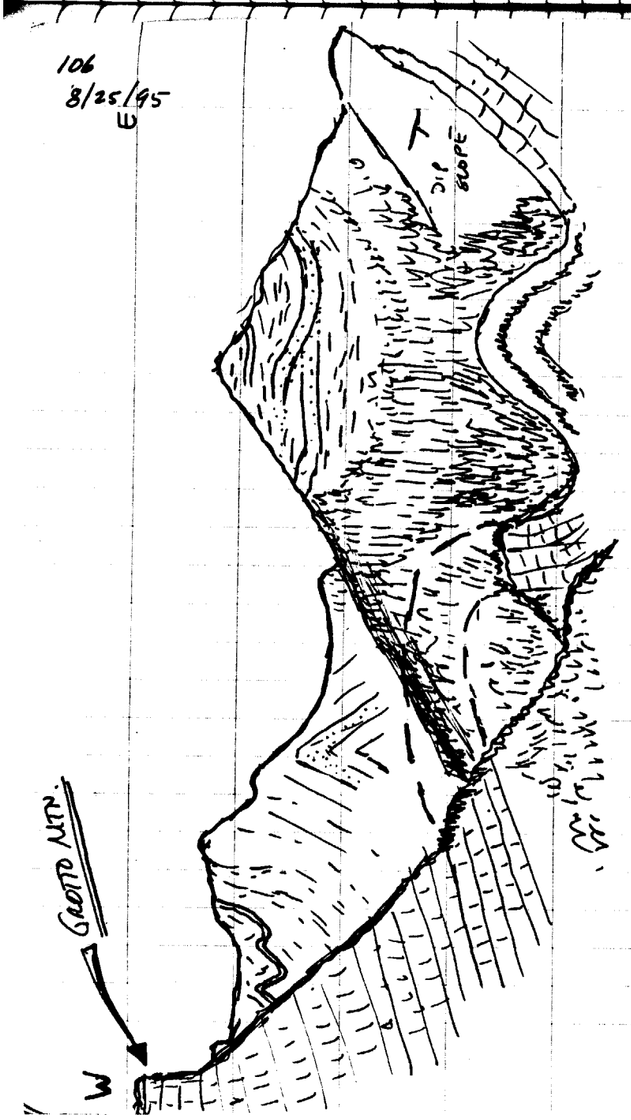
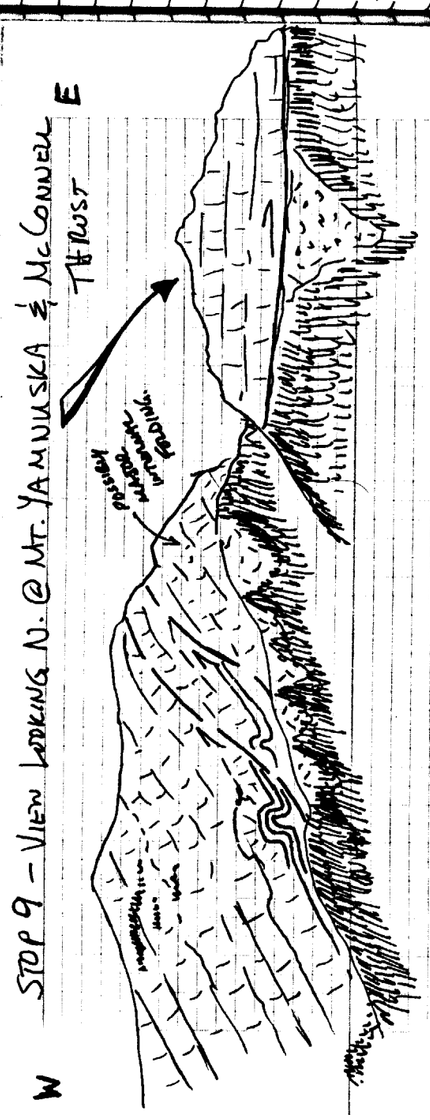
8/25/95



107
8/25/95



STOP 9 - VIEW LOOKING N. @ MT. YAMNUSKA & McCONNELL THRUST

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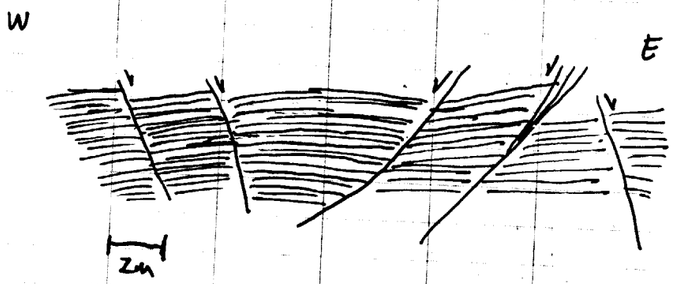
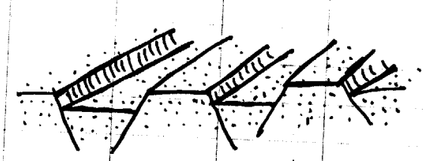
8/25/95

UNOFFICIAL STOP @ SEEBE DAM
NEAR STOP 9.



- UK Marine - Watiabi Fm (above)
- Cardium Sandstone (beneath)



EXTENSIONAL FAULTS CUT SMALL CONTRACTIONAL FAULTS.

BILL DUNNE NOTED EXTENSIONAL AND CONTRACTIONAL FAULTS, PLUS RED ⊥ FAULTS w/ RED-II SLICKENSIDES.

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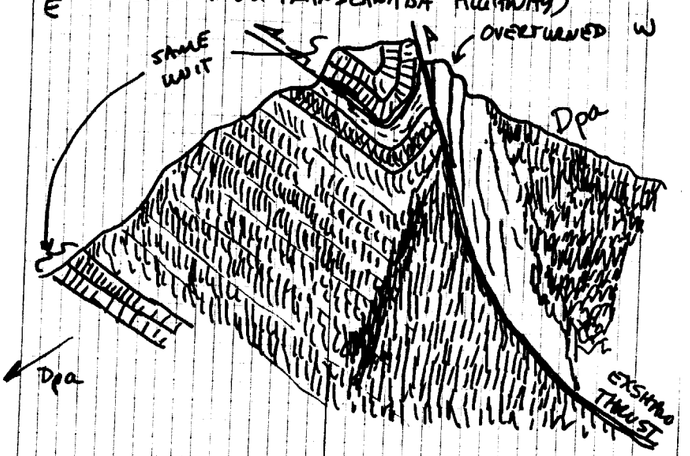
8/25/95

STOP 11 - EXSHAW THRUST AT HEART MOUNTAIN

HEART MOUNTAIN
(VIEW FROM TRANSCANADA HIGHWAY)



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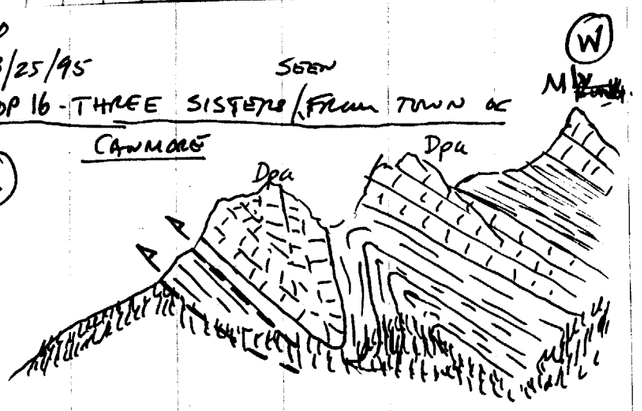
8/25/95

STOP 16 - THREE SISTERS (FROM TOWN OF CANMORE)



111
13 Nov. 1995

FIELD WORK AT BARE MOUNTAIN, NEVADA

- FLEW TO VEGAS & DRIVE TO BEATTY (BUDGET INN) 12 NOV. 95
- FIELD PARTY: ALAN MORRIS, JOHN STAMATAKOS, BRET RAHE, SIDNEY JONES, DAVID FERRILL.

- PURPOSES: A. PALEOMAGNETIC SAMPLING AT AND AROUND BARE MOUNTAIN TO CONSTRAIN 1) VERTICAL-AXIS ROTATIONS (& HORIZONTAL-AXIS)
  2) AGE OF LANDSLIDE AT SOUTH END OF BARE MOUNTAIN.

  B. STUDY FAULT BLOCK AND FAULT ZONE DEFORMATION MECHANISMS IN BARE MOUNTAIN. → MAP LISTRIC NORMAL FAULTS NEAR CANADA AND STUDY/SAMPLE RELATED DEFORMATION FEATURES INCLUDING i) EVIDENCE FOR DOWN-DIP SHEAR AND ii) EVIDENCE OF SEISMIC VS ASEISMIC SLIP ON FAULT

112
12 Nov. 1995

SEGMENTS AT DIFFERENT DIP.

* COMPASS DECLINATION SET ON 14.5°.

STOP 1. HEAD OF TARANTULA CANYON

→ HAULED WATER TO PASS BETWEEN TWO EXPOSURES OF ORDOVICIAN ANTELOPE VALLEY FM (OAV) AT NE HEAD OF TARANTULA CANYON DRAINAGE BASIN.

→ J. STAMATAKOS & BRET RAHE SAMPLING FOR PALEOMAG. ANAL.

→ WE SAMPLE FOR MICROSTRUCTURAL ANALYSIS.

→ SEVERAL PANORAMIC PHOTO'S → N, W, E.

DFBM 5B - ANTELOPE VALLEY FORMATION.

COARSE GRAINED LIMESTONE SAMPLED FOR MICROSTRUCTURAL ANALYSIS.

DFBM 5BA

↑ 011/36 W → MARKED ON TOP BEDDING

BEDDING.

113
13 NOV. 95

DFBM 5BB C.G. OAV. → SAME BED AS DFBM 5BA

↑ 032/44 W MARKED ON TOP BEDDING.

BEDDING

DFBM 5BC - VEINS IN MEDIUM TO COARSE GRAINED LIMESTONE ~AT TERMINATION OF ~BED 11 SHEAR ZONE.

✕

↑ 282/15 S MARKED ON ARBITRARY SURFACE.

↑ 053/24 W BEDDING MEASUREMENT.

DFBM 5BD -

↑ 032/05 NW → ORIENTATION MARKED ON UPPER BEDDING SURFACE

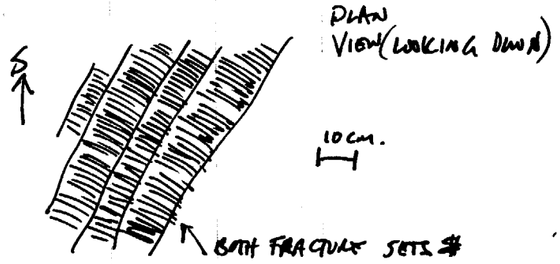
- 3 PIECES THAT FIT TOGETHER NICELY
- COLLECTED FOR ~BED-11 VEIN

114
13 NOV. 95

DFBM 59 - CARBONATE ROCK FROM FOOTWALL OF FAULT

102 ↑ 016 ORIENTATION MARKED ON FRACTURE SURFACE.

- ROCK IS INTENSELY FRACTURED.
- PHOTO'S OF ⊥ FRACTURE SETS.



115
14 NOV. 1995

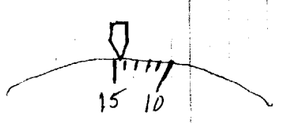
BARE MOUNTAIN, NEVADA.

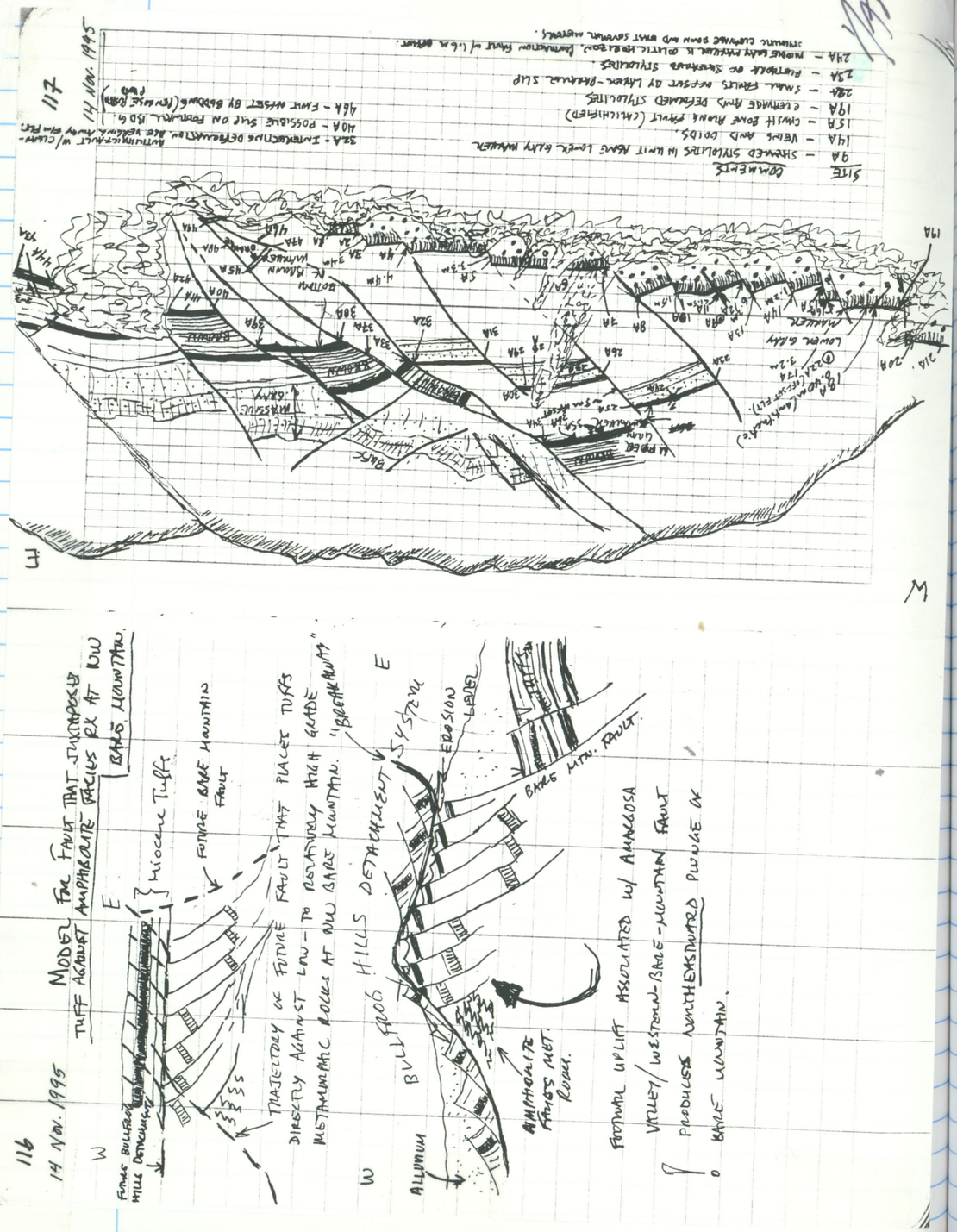
STAYING AT BULLFROG INN, BEATTY, NEVADA.
PERFECT WEATHER

— JOHN STAMATAKOS & BRET RAHE DRILLING PALEOMAG SAMPLES OF OAV IN NORTHWESTERN BM.

— ALAN MORRIS, SID JONES & DAVID FERRILL MAPPING FAULTS, USING PLANE TABLE & ALIDADE, IN CANYON NORTH OF CARRARA CANYON ~1 MI. DUE EAST OF GOLD ACE MINE ON WEST SIDE OF BARE MTN.

NOTE: COMPASS DECLINATION SET TO 14.5°





SEGMENT OF FERRILL & MORRIS POSTER FROM "FAULT-RELATED FOLDING" PENROSE CONFERENCE
AUGUST 1995
IN BANFF HUSSEIN

POSSIBLE SAMPLE LOCATIONS

B5 – Crush zones at fault also smooth fault surface in places.

B8 – DEFORMED STYLOLITES IN HANGINGWALL
↳ ALSO, SHEAR FRACTURES CONSISTENT W/ DOWN-DIP SHEAR.

B3 – BED – PARALLEL SHEAR ZONE.

Figure 4. Oblique areal photograph of western Bare Mountain northwest of Carrarra Canyon.

Figure 5. Photograph of western Bare Mountain at Carrara Canyon.

Figure 6. Normal fault offset by down–dip layer–parallel shear.

Figure 7. Stylolites in marble sheared in down–dip direction.

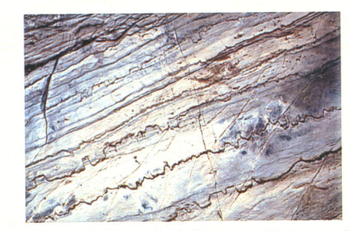


Figure 8. Undeformed stylolites suggest that down–dip layer–parallel shear is not uniformly distributed.

118
15 Nov. 1995.

MAPPING FAULTS IN CANYON DUE EAST OF GOLD ACE MINE – WESTERN BARE MOUNTAIN.

→ D. FERRILL, A. MORRIS, S. JONES.

NOTE: THIS SITE IS AT THE HEAD OF WESTERN BARE MOUNTAIN FAN 4 (SEE FERRILL et al. 1995 FAULTING MATRIX MILESTONE AND GEOLOGY MANUSCRIPT).

→ ANOTHER BEAUTIFUL CLEAR, WARM DAY.

MAPPING –

→ SEE NOTES OF SURVEYED LOCALITIES ON FIELD SKETCH ON P. 117.

119
16 Nov. 95

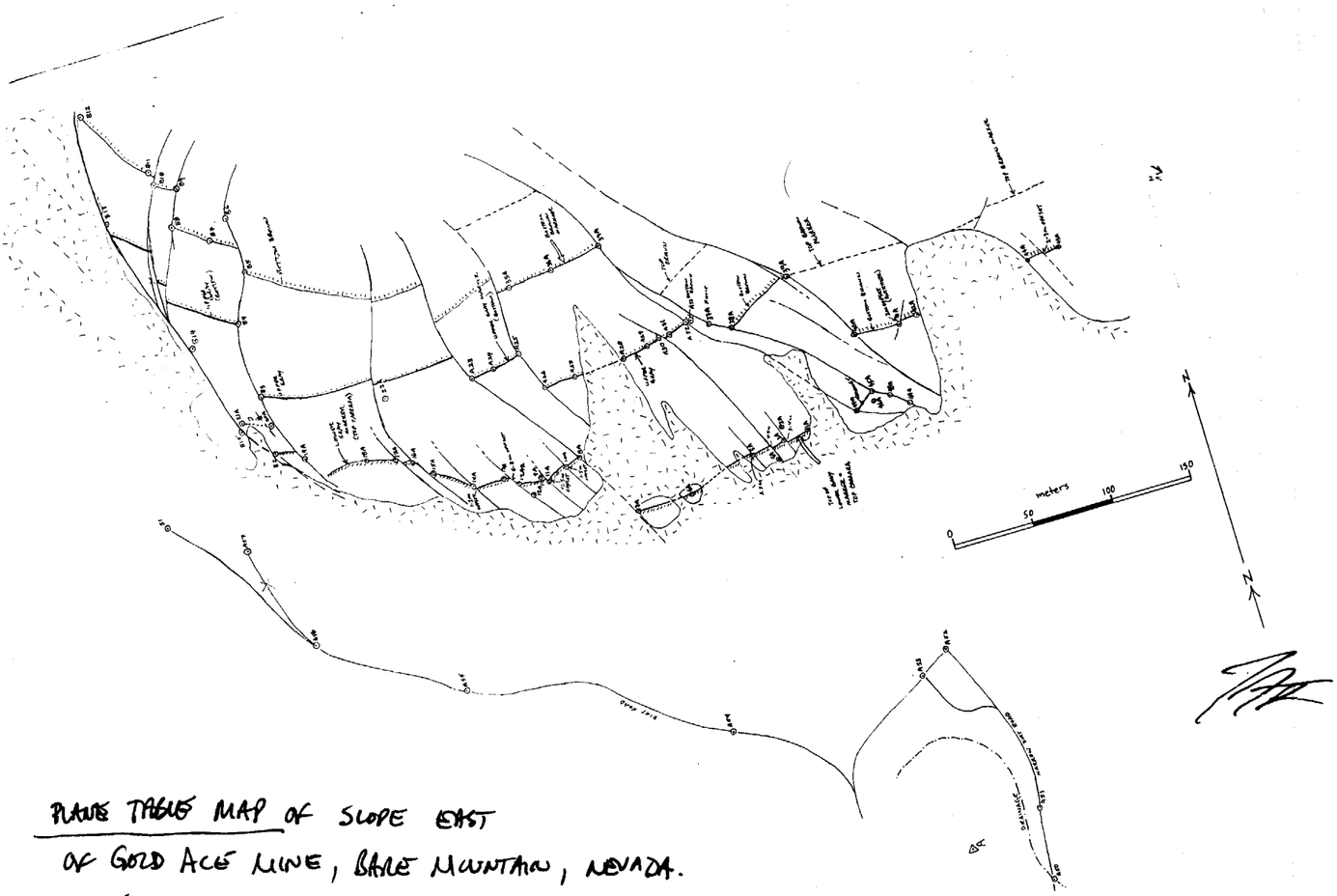
MAPPING FAULTS IN CANYON DUE EAST OF GOLD ACE MINE - WESTERN BARE MOUNTAIN

→ D. FERRILL, A. MORRIS, S. JONES

→ YET ANOTHER BEAUTIFUL DAY. SLIGHTLY COOLER THAN YESTERDAY.

→ STARTING BY RESURVEYING STATION 40A.

→ SEE FIELD SKETCH on P. 117 FOR LOCATIONS OF SURVEYED SITES AND NOTES OF POTENTIAL SAMPLE LOCALITIES.



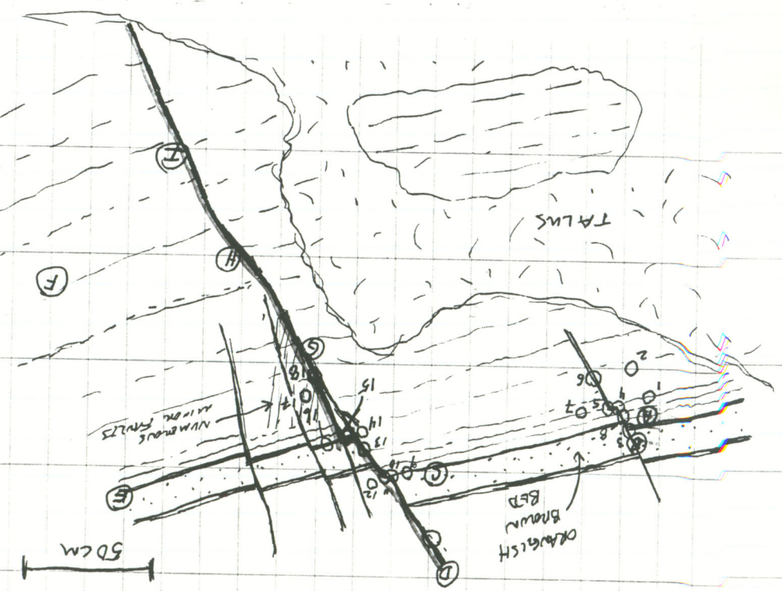
PLANE TABLE MAP OF SLOPE EAST OF GOLD ACE MINE, BARE MOUNTAIN, NEVADA.
(SEE SUPPORTING DOCUMENTATION IN NOTES OF SIDNEY JONES AND ALAN MORRIS.)

120
17 NOV. 1995
SAMPLING AT CANYON DUE EAST OF GOLD ACE MINE. SAMPLE SITES ARE THOSE MAPPED ON EAST-OF-GOLD ACE MINE COAM).

121
17 NOV. 95.

Ⓐ ↘ 068/65N BEDDING
Ⓑ ↳ 160/67E NORMAL FAULT
Ⓒ ↘ 065/58N BEDDING
Ⓓ ↳ 171/55E FAULT
Ⓔ ↘ 065/58N BEDDING
Ⓕ ↘ 067/57N BEDDING
Ⓖ ↳ 152/54N FAULT
Ⓗ ↳ 195/45N FAULT
Ⓘ ↳ 153/63W NORMAL FAULT

NOTE: MY BRUNTON COMPASS DECLINATION IS SET TO 14.5°.

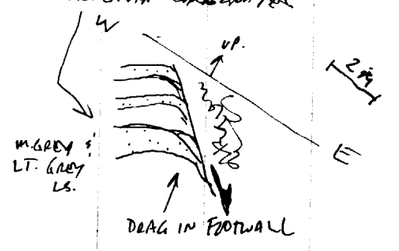


FIELD SKETCH OF FAULTS AND OFFSET FAULTS AT GAVILAN

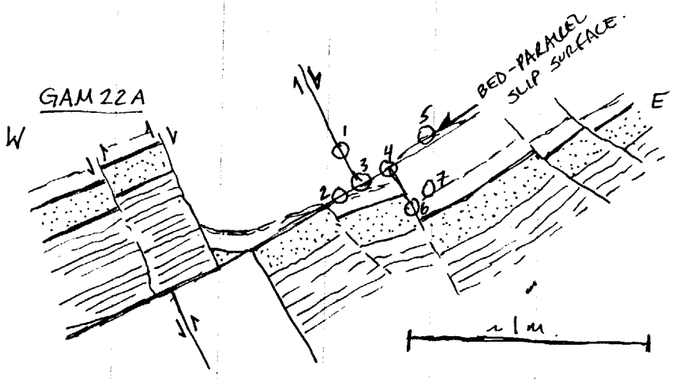
122

17 NOV. 1995

* PHOTOS OF DEFORMED FOSSILS + STYLOL.'S @ IN HANGINGWALL. GAM UPSLOPE FROM 47A
* NUMEROUS PHOTOGRAPHS OF EXTENSIONAL FAULTING IN HANGINGWALL OF FAULT AT GAM 40A. } NORMAL DRAG IN HW AND FW.
* PHOTO'S OF FABRICS IN FOOTWALL OF FAULT AT GAM 40A.
→ NEG. GAM CARBONATITE



GAM 22A



SAMPLES 7 AND 8 ARE FROM STRUCTURALLY LOWER FAULT ZONE ~8M WEST OF THIS LOCALITY.

123

18 NOV. 1995

SAMPLING BASALT ALONG MESA BUTTE, SAN FRANCISCO VOLCANIC FIELD, ARIZONA

JOHN STAMATAKOS, MIKE CONWAY & DAVID FERRILL DRIVE FROM LAS VEGAS TO FLAGSTAFF.

→ DRIVE TO RED MOUNTAIN AND HIKED TO AMPHITHEATRE BREACH IN SEARCH OF SOLID ROCK FOR ARGON-ARGON DATING, CHEMICAL ANALYSIS AND P'MAG. @ BREACH IN CONE
→ NO SOLID ROCK! ONLY BEDDED SCORIA. LAYERED CINDERS.

→ SAMPLED FLOW NORTH OF RED MTN. CORE SAMPLES RECORDED BY M. CONWAY (FOR DATING) AND JOHN STAMATAKOS (FOR P.MAG.)

NOTE: CHANGED COMPASS DECLINATION TO 0° FOR SAMPLING AT SAN FRANCISCO VOLC. FIELD

124

19 NOV. 1995

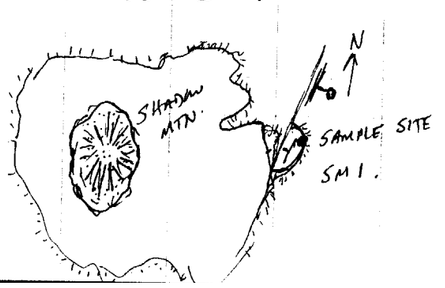
SAMPLING FOR Ar/Ar DATING AND P'MAG REVERSAL STUDIES — SAN FRANCISCO VOLCANIC FIELD.

SHADOW MTN.

SM1 - • 3 SAMPLES COLLECTED FOR P'MAG ANALYSES (RECORDED BY JOHN STAMATAKOS. (SM1-1 → SM1-3).

• BAG OF FRESH ROCK COLLECTED FOR DATING. → RECORDED BY MIKE CONWAY.

• SAMPLES COLLECTED FROM EASTERN EDGE OF SHADOW MTN FLOW. BLOCKS TILTED TO NORTHWEST ~15-20°.



125

19 NOV. 1995

CEDAR RANCH FAULT

SITE OF MB-02 — COLLECTED 3 SAMPLES FOR P'MAG ANALYSIS AT SITE OF MB-02 SAMPLES FROM

CR-1 (Cedar Ranch 1) — WHICH CHEMICAL ANALYSES AND Ar/Ar DATING WAS DONE.
Ar/Ar AGE FOR THIS SITE IS 1020 Ka.

SITE OF MB05 — * COLLECTED 3 SAMPLES FOR P'MAG.
* 2 OUT OF 3 REVERSED COMPASS NEEDLE AT OUTCROP.

CR2 (Cedar Ranch 2) * SAMPLES RECORDED BY J. STAM.

FV-1 (Fan 14 Vent 1) * VENT ALONG MESA BUTTE FAULT APPROX. 1 MI. NE OF MB-04.

CR-3 (Cedar Ranch 3) * "DOME" FLOW APPROX. 1 MI. NE OF THE RANCH ALONG CEDAR RANCH FAULT ESCARPMENT.

126

20 NOV. 1995 → MY 33RD BIRTHDAY.

SAMPLING BASALTS IN VICINITY OF MESA BUTTE, SAN FRANCISCO VOLCANIC FIELD, AZ

M. CONWAY, J. STAMATAKOS, MYSELF

PURPOSE: DATING & PMAG.

CHAPEL MOUNTAIN

CM1-1 THROUGH CM1-3. PMAG SAMPLES (SEE J STAM. NOTES).
VENT ~1/4 mi NE OF CHAPEL MTN. (MIDDLE OF THE 3 VENTS).
→ LOTS OF OLIVINE.

CM1-4. DATING SAMPLE (M. CONWAY NOTES).

CM1-5 - DATING SAMPLE ~ 100 M. SOUTHWEST AND DOWN SLOPE FROM CM1-1 → 4.
MASSIVE FLOW INTERIOR - ABUND AND OLIVINE (15-20%)

127

20 NOV. 1995

CM2 → FLOW EXPOSED IN GULLY. SOURCED FROM CHAPEL MTN. TO SOUTHWEST.

→ MASSIVE FLOW INTERIOR 15-20% + OLIVINE.

TW1 - Tappan Wash Flow
SAMPLES FROM SITE OF x6122' BENCH MARK, ~1½ mi. EAST OF TUB RANCH.

TW1-1
TW1-2
TW1-3
} SAMPLES FOR PMAG ANALYSIS (ORIENTATION RECORDED BY J STAM.)

TW1-4 - SAMPLE FOR DATING.

128

[illegible] MAY 1996.

YUCCA MOUNTAIN REGION, NEVADA

AFTER AAPG MEETING IN SAN DIEGO, CA.

MET SID JONES AND BRET RAHE IN LAS VEGAS ON 5/23/96.

* COMPASS DECLINATION SET 014.5°

SAMPLING IN STRIPED HILLS

PURPOSE: COLLECT PMAG, MICROSTRUCTURE (CARBONATES) AND POSSIBLY FISSION TRACK SAMPLES.

DFSH3 → ORDOVICIAN ANTELOPE VALLEY FORMATION → NORTHERN STRIPED HILLS.

+ 080/65S OVERTURNED.
+ 076/50 S OVERTURNED

129

24 MAY 1996.

~2m THICK CALCITE VEIN SYSTEM PARALLEL

YELLOW-ORANGE COARSELY PRISMATIC VEIN FILL (BED-⊥ PRISMS) CUT BY WHITE PRISMATIC VEINS THAT ARE PLANAR TO ANASTOMOSING (0.5-12cm THICK). SOME THIN REDDISH VEIN MATERIAL (BANDS) W/ WHITE VEINS.

LOCALLY, WHITE VEINS AT HIGH ANGLE TO BEDDING CUT YELLOW-ORANGE VEINS.

ALSO - WELL DEVELOPED SYSTEM OF BED ∥ AND BED ⊥ VEINS IN ADJACENT WALL ROCK - BOTH WHITE AND YELLOW VEIN FILL.

THICK VEINS APPEARS TO BE OFFSET BY FAULTS AT HIGH (~⊥) TO BEDDING

DFSH3-10 HAND SAMPLE FOR M.S. ANALYSIS.

UNORIENTED SAMPLE OF THICK (2M) BED PARALLEL VEIN SYSTEM.

(DFSH3-1 → 9 } → LOGGED BY S. JONES)

130
5/24/96

DFSH3-11 - MICROSTRUCTURAL SAMPLE - OAU
✱ 075/56 S OT.

NOTE: SAMPLE BROKE ALONG BEDDING INTO TWO PIECES.
UP ARROWS MARK GEOGRAPHIC UP, STRIKE/DIP MARKED ON GEO. TOP BEDDING. (STRATIGRAPHIC BOTTOM)

DFSH4 - 1 → 10 PMAG CORES DRILLED FROM ORDOVICIAN ANTELOPE VALLEY FM.

DFSH5 - ORDOVICIAN ANTELOPE VALLEY FM - SNAMPED HILLS (NW CORNER)
#'s 1 → 9 → 9 Paleomag. core samples

DFSH5-10 → MICROSTRUCTURAL ANALYSIS SAMPLE:
#10

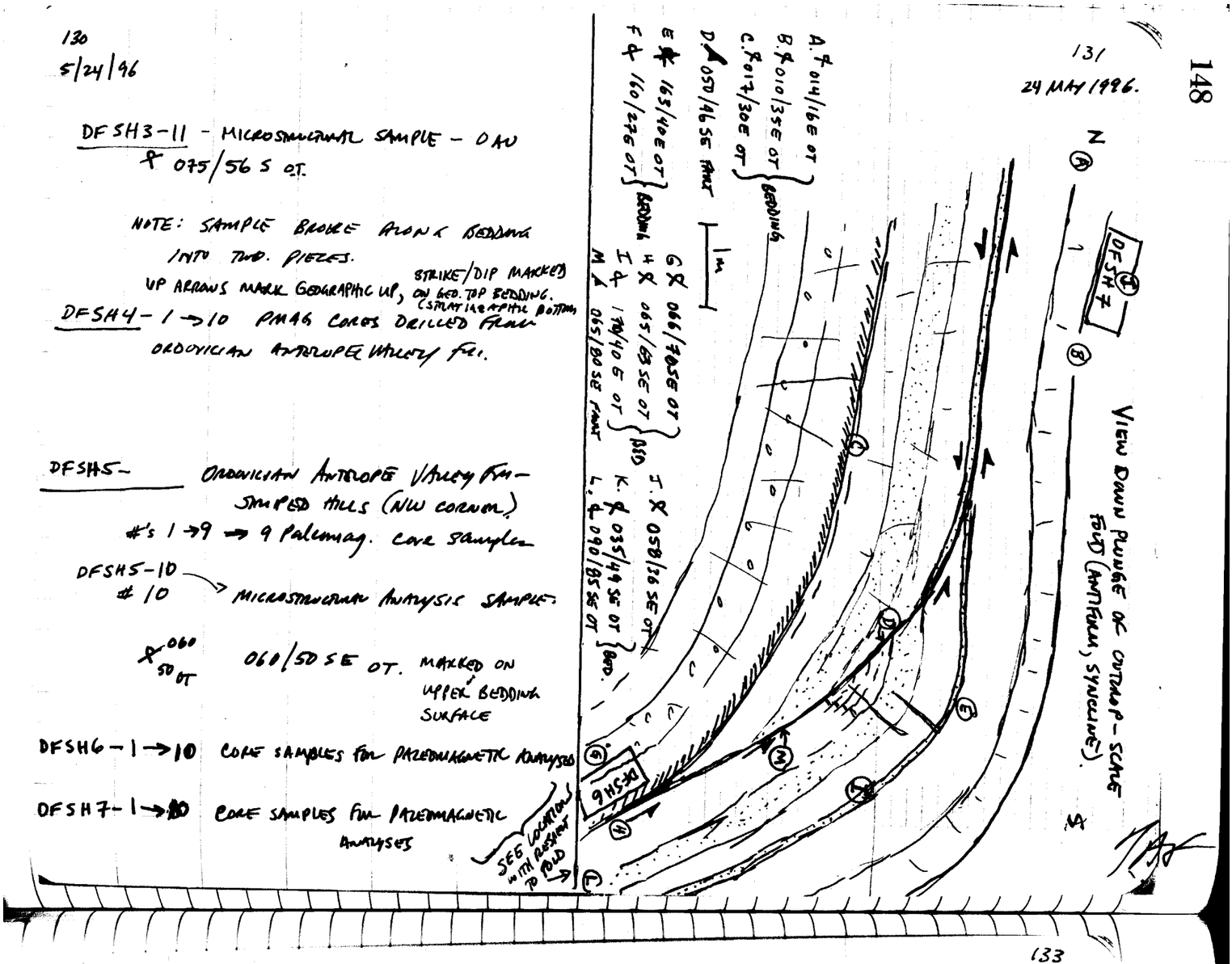
✱ 060/50 OT — 060/50 SE OT. MARKED ON UPPER BEDDING SURFACE

DFSH6 - 1 → 10 CORE SAMPLES FOR PALEOMAGNETIC ANALYSES

DFSH7 - 1 → 10 CORE SAMPLES FOR PALEOMAGNETIC ANALYSES

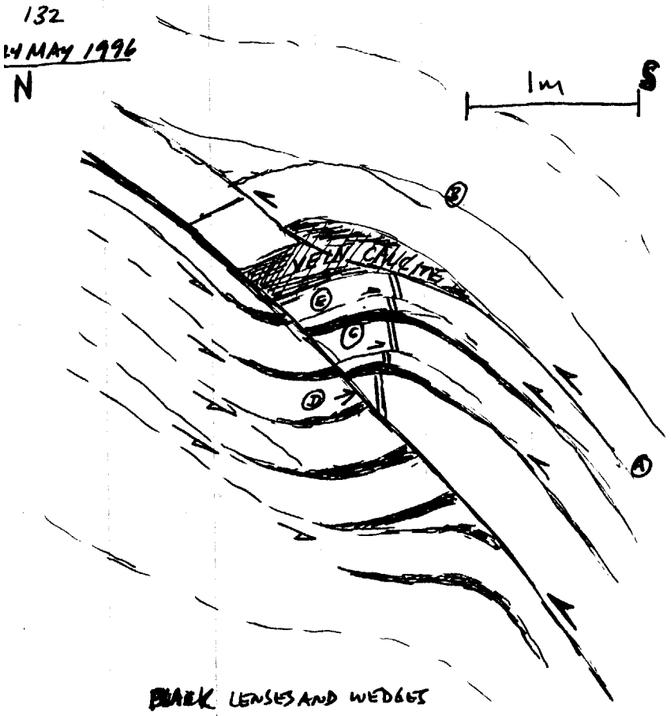
SEE LOCATIONS IN ITH RESPECT TO ROAD →

131
24 MAY 1996.



133
25 MAY 1996

132
24 MAY 1996



BLACK LENSES AND WEDGES AN SIGTH ARE CALCITE VEINS.

A. ✱ 057/55 SE OT.
B. ✱ 036/52 SE OT } BEDDING
C. ✱ 159/58 E OT
D. ✱ 050/43 SE FAULT
E. ✱ 153/69 E OT } BEDDING

SATURDAY 25 MAY 1996

✱ NEVADA TEST SITE.

SAMPLING FOR P'MAG, MICROSTRUCTURE (IN CARBONATES) AND FISSION TRACK ANALYSES.

PERSONS PRESENT: BRET RATHE,
SID JONES
DAVID FERRILL

SAMPLING NORTH OF MERCURY

DFM2

ORDOVICIAN EUREKA QUARTZITE.
SAMPLES FROM 2 DIFFERENT BEDS FOR FISSION TRACK ANALYSES. (NOT ORIENTED)

✱ 5 PIECES

134

25 MAY 1996.

DFM1 → ANTELOPE VALLEY FM, NORTH OF MERCURY
ORIENTED SAMPLES OF ORDOVICIAN ANTELOPE VALLEY FM.

DFM1-17 - MICROSTRUCTURAL SAMPLE
155/16 E → BEDDING
(ORIENTATION MARKED ON BEDDING SURFACE).

DFM1-18 - MICROSTRUCTURAL SAMPLE
013/12E → BEDDING.
· (ORIENTATION MARKED ON BEDDING SURFACE).

DFM1-1 → 16 CORES DRILLED FOR PALEOMAGNETIC ANALYSES.

* ORIENTATIONS RECORDED BY SID JONES.

135

25 MAY 1996

DFYF1

SAMPLES OF CRETACEOUS GRANITIC INTRUSIVE.

NORTHWEST EDGE OF YUCCA FLAT
101-94 Ma BY Age by Naeser and Maldonado.

· 3 PIECES.

DFYF2

MISS. ELEANA FORMATION, WEST EDGE YUCCA FLAT
CONGLOMERATE COLLECTED FOR FISSION TRACK ANALYSIS
· 5 PIECES

DFYF3 WEST YUCCA FLAT
QUARTZITE (SS) OF MISSISSIPPIAN ELEANA FORMATION COLLECTED FOR FISSION TRACK ANALYSIS
· 4 PIECES

136

25 MAY 1996

DFYF4 - ORDOVICIAN EUREKA QUARTZITE
SOUTHWEST YUCCA FLAT
· 5 PIECES COLLECTED FOR FISSION TRACK ANALYSIS

DFYF5 - LIMESTONE, ORDOVICIAN POGONIP GROUP → PROBABLY ANTELOPE VALLEY
- SOUTHWEST YUCCA FLAT.

DFYF5-1 → 10. PMAG CORES RECORDED IN FIELD BOOK BY SID JONES.

DFYF5-11. ORIENTED HAND SAMPLE FOR MICRO-
355/57E STRUCTURAL ANALYSIS.

DFYF5-11 - UNORIENTED HAND SAMPLE OF POGONIP LIMESTONE
→ COARSE GRAINED.

137

25 MAY 1996.

DFYF6. ORDOVICIAN POGONIP GROUP SAMPLED FOR PALEOMAGNETIC ANALYSES.

DFYF6-1 → 8 - CORES DRILLED IN THE FIELD

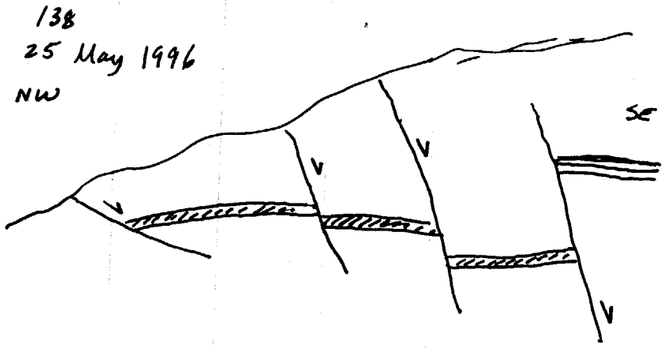
DFYF7 ORDOVICIAN EUREKA QUARTZITE COLLECTED FOR FISSION TRACK ANALYSES

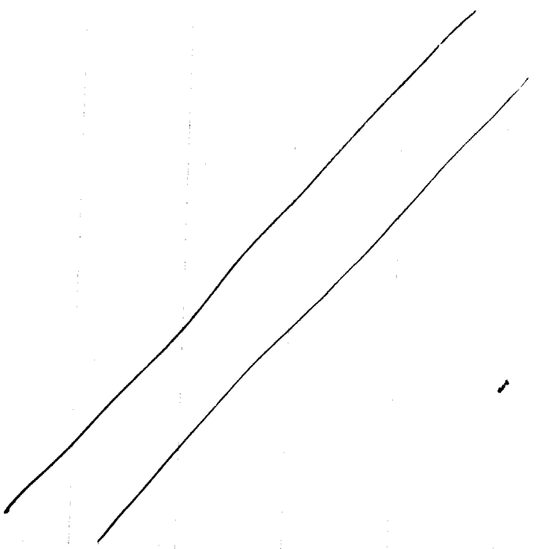
8 PIECES.

GOLD ACE MINE EXPOSURE, BARE MTN. (NV).

- DROVE TO SADDLE @ N. END OF GAM EXPOSURE.
- HIKED UP KNIFE RIDGE (TOP OF EXPOSURE).
- VALLEY N. OF GAM EXPOSURE EXPOSES SEVERAL FAULTS WHICH CORRELATE W/ FAULTS ABOVE UPPER DETACHMENT AT GAM EXPOSURE.

138
25 May 1996
NW





139
26 May 1996

26 MAY 1996

D. FERRILL & JOHN STAMATAKOS.

DROVE FROM BEATTY (NV) THROUGH TONOPAH (NV) TO BISHOP, CALIFORNIA.

→ DROVE AROUND ON VOLCANIC TABLELAND NORTH OF BISHOP, CALIFORNIA.

- PHOTOGRAPHED LATERAL THROW GRADIENTS ON FAULTS, FAULT TIPS, RELAY RAMPS.

---

27 May 1996

27 MAY

→ DROVE AROUND ON VOLCANIC TABLELAND

→ AGAIN PHOTOGRAPHING FAULTING OF WELDED TUFF.

→ EXITED TABLELAND @ N. END → CROSSING CROWLEY LAKE DAM.

140
27 May 1996

- BOULDERING @ BUTTERMILKS

- DROVE BIG PINE, WAUCOBA RD. THROUGH INYO'S, SALINE VALLEY (VISITED PALM SPRING, HOT SPRING) HUNTER MTN, DARWIN PLATEAU, PANAMINT VALLEY, PANAMINT RANGE DEATH VALLEY (SUPPER @ FURNACE CR. RANCH), BEATTY.

- LOT'S OF PHOTOGRAPHS.

- EXCEPTIONALLY LONG BUMPY RIDE, PROBABLY TO LONG FOR ADVANCED STRUCTURE FIELD COURSE.

141
28 MAY 96.

BARRICK BURRFROG MINE
VISITED TOM JOHN @ MINE.

- PRESENTED BARE MTN. STUDIES TO TOM JOHN & BART EKREN.
  - REGIONAL CONTEXT AND PURPOSE
  - ZIRCON FT.
  - APATITE FT
  - P'MAG @ MEIK. PEAK.
  - CALCITE DEFORMATION
  - STRAT SECTION (PLUNGE NE)
  - STRUCTURAL PLUNGE DATA
  - REGIONAL DETACHMENT
  - MAGNETICS OF CF.

- TOUR OF MINE

① - MAIN PIT, LADD MTN
- BASALT DIKE IN UP FAULT → MAIN TARGET
→ LOTS OF QTZ, CALCITE AND MANGANESE.

142
28 MAY 1996

SAMPLES

Bullfrog Mine.

DFBFM1.1 ← MAIN ORE UNIT ↗ Calcite Qtz, Mn.
DFBFM1.2 ← GREEN BRECCIATED, ASSOCIATED w/ MAIN SEAM AT BULLFROG MINE MAIN PIT (LADD PEAK)
DFBFM1.3 } VEINS
DFBFM1.4 } BRECCIATION
DFBFM1.5 ← GREEN w/ THIN FAULTS AND FRACTURES

② MONTGOMERY MTN. – CONTACT FAULT (NE–SW TRENDING) w/ BASALT FLOWS AND DIKE AT INTERSECTION (HIGH ANGLE) w/ 2 INTERSECTING FAULTS.

③ WEST OF RHYOLITE

DFBFH1 → [→ Pz carbonate ← SAMPLES FOR MICROSTRUCTURAL ANALYSIS ↑ NOT ORIENTED.
→ Early Tertiary Gravel
→ Tuff
→ Qtz latite

143
28 MAY 96

DFBM60 –

CARBONATE BRECCIA FROM LOW HILL IMMEDIATELY SOUTH OF BLACK MARBLE MTN. – NOT ORIENTED

RING OF "BASALT SCHLUMP" AROUND LIMESTONE KNOLL → ANALOGOUS TO BATHUB RING → ANTIPODE OF ATOLL.

DFBM61 –

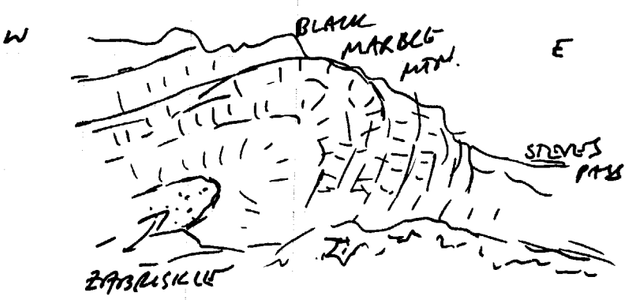
QUARTZITE SAMPLES FROM SOUTH END OF BLACK MARBLE COLLECTED FOR FISSION TRACK ANALYSES.

144
28 MAY 1996

DFBM 62 –

ZABRISKIE QUARTZITE SAMPLE FROM LOW HILL OF ZABRISKIE QTZITE IN CORE OF BLACK MARBLE EAST-VERGENT ~~N~~ RECUMBENT ANTICLINE.

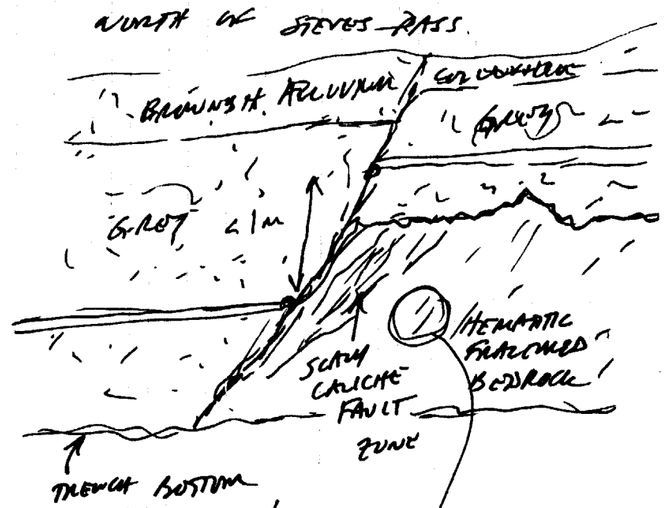
SAMPLE COLLECTED FOR FISSION TRACK ANALYSES



VIEW N. AT FOLD PROFILE BLACK MARBLE MTN SOUTHERN BARE MTN

145
28 MAY 96

NEW BARE MTN FAULT TRENCH NORTH OF STEVES PASS.



DEFORMED & ALTERED WOOD CANYON

DFBM63.1 → HEMATITIC

DFBM63.2 → HEMATITIC w/ GREEN MINERALIZATION

SAMPLES FROM FOOTWALL OF FAULT TO STUDY MICRO-SCALE DEFORMATION FRACTURES & MINERALIZATION

146
29 MAY 1996

— 29 MAY 1996.

- BEATTY NEVADA, BUNDO INN
- TIRE PATCHED
- DRIVE TO SHOSHONE TO MEET TERRY PAULS.
- W/ TERRY AND FIELD ASSISTANT (CARRIE?) TOUR SOUTHERN BLACK MTNS, AMARGOSA CHAOS, DESERT HOUND ANTICLINE, MORMON POINT TURTLEBACK, FAULTED TURTLEBACK ALLUVIUM, COPPER CANYON TURTLEBACK, SOUTHERN DEATH VALLEY, CONFIDENCE HILLS, SARATOGA SPRINGS (pЄ BASEMENT & pЄ SECTION + PUPFISH!), ANAMITI MOUNTAINS → WENT TO CAMP NEAR EDGE OF FORT IRWIN AT IRON ORE MINE.

BENNIE TROXEL EXPLANATION POINT ≡ "EXCLAMATION POINT"

→ DROVE BACK TO SHOSHONE.

147
29 May '96.

SUPPER AT BENNIE TROXELS HOUSE:

DAVID FERRILL
JOHN STAMATAKOS
TERRY PAULS
LAURA SERPA
BENNIE TROXEL
JOHN COOPER
MARTIN ? (GERMAN) } WORK TOGETHER
CARRIE ?

WORKING P7 STRATIGRAPHY

→ JOHN COOPER SAYS

PLAUSE COTTONWOODS ADJACENT TO BARE MOUNTAIN PROBABLY OK BASED ON STRATIGRAPHY (ESP. CARRARA FALLS).

BARE MTN. APPEARS TO BE MORE BASINAL THAN SLIPPED HILLS → WILL SEND ME SOME GRAY LOTTERS

MEASUREMENT CONVERSIONS

"Rite in the Rain"®
ALL-WEATHER WRITING PAPER

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TEL: (210) 522-6082
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"Rite in the Rain" is a unique all-weather writing surface created to shed water and to enhance the written image. Makes it possible to write sharp, legible field data in any kind of weather.

2

3

5 August 1996.

FIELD WORK IN YUCCA MOUNTAIN/ DEATH VALLEY REGION

PERSONS: D.A. FERRILL (CNWRA)
WILLIAM H. DENNIS (UNIV. OF TENN.)

PURPOSES: ① COLLECT FISSION TRACK SAMPLES FROM DEATH VALLEY EXTENSIONAL CORRIDOR SOUTH OF YUCCA MTN (OUTSIDE DEATH VALLEY NAT'L. PARK).

② FIELD RECONNAISSANCE OF FRACTURES AT YUCCA MOUNTAIN. REVIEW OF DOE-FUNDED FRACTURE STUDIES. — INCLUDING TOUR OF ESF.

DRIVE FROM LAS VEGAS WEST TO RED ROCKS, ACROSS SPRING MTNS., N. THROUGH PAHRUMP VALLEY TO MT. STIRLING VICINITY.

4

5 August 1996

DAVID FERRILL MT. STIRLING

DFMS1 - SAMPLE OF ZABRISKIE QUARTZITE ON NORTHEAST SIDE OF (16), ~3 km NORTH OF JOHNNIE. EAST OF MT. STIRLING PEAK.

3 PIECES COLLECTED, ALL LABELLED DFMS1

• SAMPLE LOCATION MARKED ON NEVADA STATE GEOLOGIC MAP.

DFMS2 - ZABISKIE QUARTZITE SAMPLE (1 LARGE PIECE) COLLECTED FOR FISSION TRACK ANALYSES.

SOUTHEAST OF SAMPLE DFMS1, ~1 km. ACROSS (16) FROM TURNOFF FOR JOHNNIE MINE.

5

5 August '96

DFRSR1 - ZABRISKIE? QUARTZITE FROM N. END OF CHICAGO VALLEY AT CHICAGO PASS (WEST SIDE OF PASS). BLOCK ALONG EAST EDGE OF RESTING SPRINGS RANGE.

DFRSR2 - SAME AS DFSR2 - 2nd APPROXIMATELY 100 m SOUTH OF DFRSR1.

DRIVE SOUTH THROUGH CHICAGO VALLEY, THROUGH SHOSHONE (CA), NORTH TO DEATH VALLEY JUNCTION, WEST THROUGH FURNACE CREEK VALLEY, SW PAST RYAN TO DANTES VIEW (GOOD SPECTACULAR, LIGHTING NOT TOO GREAT), BACK OUT TO MAIN ROAD AND WEST TO FURNACE CREEK FOR SUPPER.

@ 10 PM. 105° AND WINDY AT FURNACE CREEK. DESICCATING WIND!

6

6 AUGUST 1996.

FIELD RECONNAISSANCE OF FRACTURES AND PAVEMENT EXPOSURES AT YUCCA MOUNTAIN.

ENTER NTS THROUGH AMARGOSA VALLEY GATE

CHECK IN, SIGN IN, PICK UP RADIO AT FOC.

FIRST FIELD STOP — FRAN RIDGE PAVEMENT (PAVEMENT 2001) AT SITE OF LARGE-BLOCK HEATER TEST.

COMPARING PAVEMENT 2001 MAP FROM SWEETKIND et al. 1996 KMAG MANUSCRIPT.

7

6 AUGUST '96

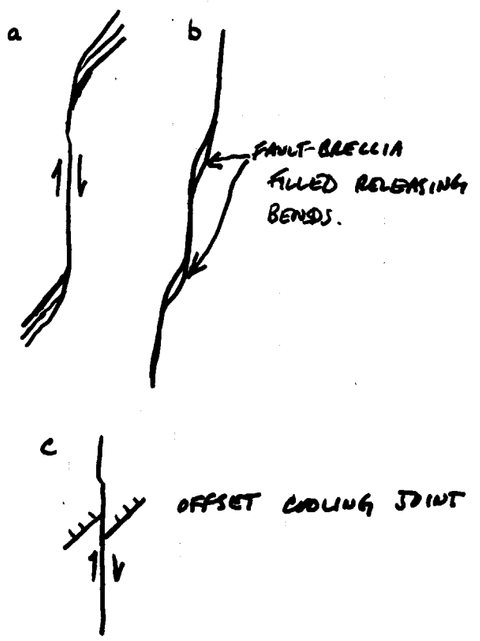
SOME OBSERVATIONS FROM FRAN RIDGE PAVEMENT -

- SWEETKIND USED THRESHOLD LENGTH OF 5 FT (~1.5 m) FOR INCLUSION OF FRACTURES IN MAP.
- SWEETKINDS INTERPRETATIONS OF FRACTURE TIMING SEQUENCE SEEM CONSISTENT WITH CROSS-CUTTING AND ABUTTING RELATIONSHIPS.
- COOLING JOINTS TEND TO BE QUITE SMOOTH, COMMONLY HAVE DARK FINER GRAINED(?) TEXTURE ON MM SCALE ALONG FRACTURE WALLS.
- FRACTURES GENERALLY MUCH LESS (VERY POORLY) DEVELOPED IN UPPER PART OF EXPOSURE WHERE SOFTBALL SIZED LYTHOPHYSAL VUGS ARE QUITE ABUNDANT.

8

6 AUGUST 1996.

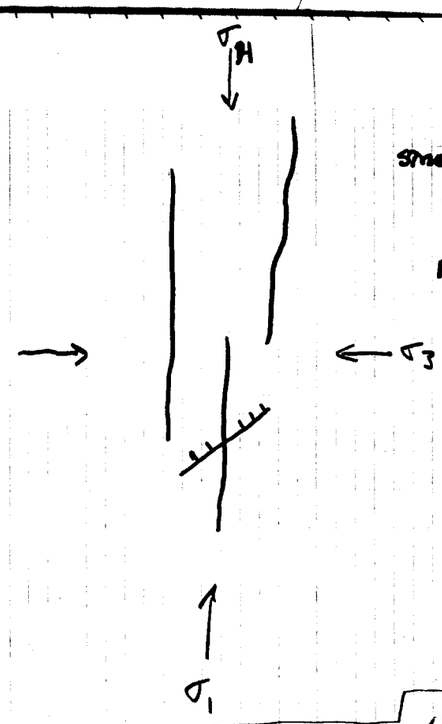
- SEVERAL FRACTURES (PARTICULARLY THOSE TRENDING 000 - 350). HAVE BEEN REACTIVATED AS RIGHT-LATERAL STRIKE-SLIP FAULTS.



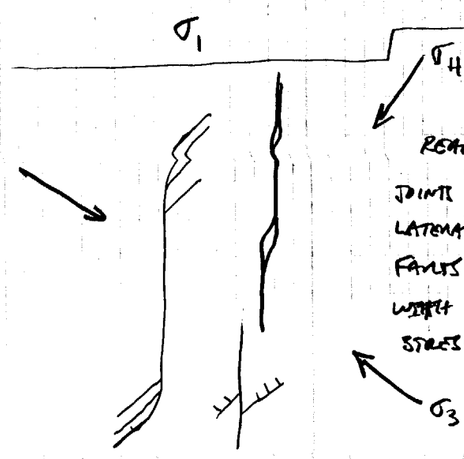
a, b, c ILLUSTRATE INDICATORS OF RIGHT SLIP SEEN IN OUTCROP

9

6 AUGUST '96.



STRESS STATE FOR ORIGINAL FORMATION OF N-S JOINTS



REACTIVATION OF JOINTS AS RIGHT LATERAL STRIKE SLIP FAULTS IS CONSISTENT WITH CONTEMPORARY STRESS STATE.

10

6 August 1996

FIELD STOP 2 – LUNCH AT YUCCA CREST

FIELD STOP 3 - UZ 7a DRILL PAD SITE.

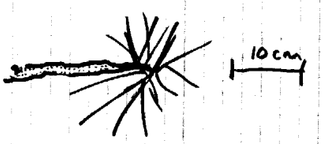
GHOST DANCE FAULT EXPOSURE.

- ROCK PAVEMENT EAST OF GHOST DANCE FAULT HAS BEEN EXPOSED/CLEANED SINCE I WAS HERE LAST TIME.
- FRACTURING OF FOOTWALL (EAST SIDE) OF GHOST DANCE FAULT CONSIDERABLY LESS INTENSE THAN HANGINGWALL SIDE.
- SEVERAL HORIZONTAL CUMULATED/COLLAPSED LITHOPHYSAE COMMONLY REMAIN OPEN AS VUGS — SOME ARE CONNECTED BY SUB HORIZONTAL FRACTURES.

11

6 Aug. 1996.

- RADIAL SWARMS OF FRACTURES ARE COMMON IN OUTCROP (10's of CM DIAMETER) AND IN MANY CASES APPEAR TO HAVE NUCLEATED AT EDGE OF COLLAPSED LITHOPHYSA



THESE FRACTURES STRONGLY RESEMBLE FRACTURES INDUCED BY EXCAVATION PROCESSES.

- UPPER PART OF FOOTWALL EXPOSURE HAS MOSSBY TEXTURE & ABUNDANT LITHOPHYSAE (NOT AS COLLAPSED AS LOWER IN FOOTWALL OR HANGINGWALL), AND IS LESS PERVASIVELY FRACTURED THAN BETTER-WELDED ROCKS DEEPER IN FOOTWALL.

12

7 August 1996

TOUR OF ESF

BILL DUNNE
CHAD GLENN
DAVID FERRILL
STEVE BERSON.

- MET CHAD @ FOC AT 730 AM.
- TUNNEL TRAINING (VIDEO)
- ESF HEADQUARTERS @ ~ 830
- TALKED W/ TOM MOYER (USGS) ABOUT TUFF DEPOSITION AND COOLING
- GHOST DANCE FAULT @ 57+30. (RIGHT WALL)

  ↗ 205/90
  70° RAKE
  ~1.5 m DISPLACEMENT

- GHOST DANCE LEFT WALL @ 57+02.

13

7 August 96

- TALKED W/ DENISE BARNES WHO IS ONE OF THE MAIN MAPPERS. SITE IS CHECKING MAP BETWEEN 53+60 AND 54+00

52+43 ~ 1 m BELOW STRING LINE

FRACTURE COATING OF CALCITE, FLUORITE, OPAL AND MANGANESE OXIDES.

SEQUENCE:
1 MANGANESE
2 FLUORITE
3 CALCITE

CHAD TOOK PHOTO.

51+00

ZONE OF INTENSE FRACTURING –

FRACTURE ORIENTATION: 88 / 140

- FRACTURES ARE STRATA-BOUND TO MIDDLE NONLITHOPHYSAL MEMBER OF TOPOPAH SPRINGS.
- BEST DEVELOPED NEAR MAJOR DISPLACEMENT (ca 25 m) IN GHOST DANCE.

14
7 AUGUST '96.

- ~ 1/4 of FRACTURES OF INTENSE FRACTURE ZONE HAVE VAPOR-PHASE MINERALIZATION.

- Mn OXIDE COATING COMMON ON TOP OF VAPOR PHASE MINERAL COATING FRACTURES.

45+00
↳ LOCATION OF ~/CHANGE IN ORIENTATION OF FRACTURES IN ZONE OF INTENSE FRACTURING.

80 110-120

~ 19+35
DRILL HOLE WASH FAULT – 2 STRANDS ~ 2m APART
6m DIP SEPARATION.
OR
20m STRIKE SEPARATION

- SLICKENSIDES ON FAULT ON BOTH WALLS OF TUNNEL INDICATE R STRIKE SLIP.

AFTER DEPARTING ESF → PHOTO'S @ UZ Fa AND P2001 → BILL DUNNE'S TUNL. NOTES.

15
7 AUGUST 1996.

BARE MOUNTAIN, NEVADA

VIEW LOOKING EAST AT W(NW?) FACING SLOPE SOUTH OF GOLD ACE MINE EXPOSURE. FAULTING APPEARS TO BE MOSTLY ~ STRATAL BOUND BETWEEN UPPER DARK GREY LAYER (w/ Ꞓbp) AND LOWER DARK GREY LAYER WHATEVER[15] Ꞓcm (MIDDLE MEMBER OF CARRARA).

16
8 AUGUST 1996.

FIELD RECONNAISANCE @ YUCCA MTN.

WILLIAM M. DUNNE
DAVID A. FERRILL.

TONSIL RIDGE PAVEMENT

ROCK PAVEMENT ON TONSIL RIDGE ON CRI (NOTE: LITHOPHYSAE ARE PRESENT.

17
8 AUGUST 1996.

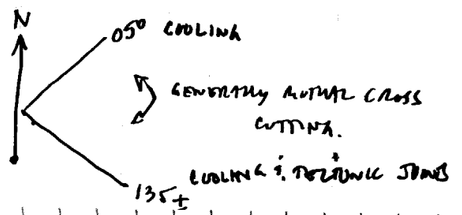
- TECTONIC JOINTS MUTUALLY CROSS CUT COOLING JOINTS.
- TECTONIC JOINTS ABUT TECTONIC JOINTS.
- ONE MAIN SET OF COOLING JOINTS
- ~10 JOINTS > 10 m IN LENGTH.
- TECTONIC JOINTS HAVE IRREGULAR SURFACE TOPOGRAPHY.

18
8 AUGUST 1996

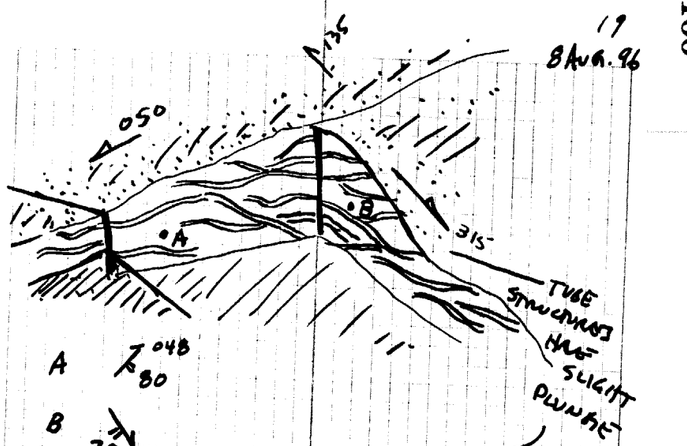
PAVEMENT 100 -

UPPER LITHOPHYSAL (TIVA CANYON) BETWEEN SPLIT WASH AND COYOTE WASH ON LIVE YUCCA RIDGE

- SWARMS OF 050-TRENDING COOLING JOINTS (8-9 JOINTS SPACED WITHIN 4m HORIZONTALLY).
- COOLING JOINTS HAVE WELL-DEVELOPED TUBULAR STRUCTURES ON SURFACES.
- PERPENDICULAR (Az 135±) COOLING JOINT ABUTS AGAINST 050 COOLING JOINTS AT EACH END.
- INTERSECTION OF 050 & 135± COOLING JOINT NOT VERTICAL.



19
8 AUG. 96



NOT EXPLAINED BY EAST DIP OF LAVA-GRAIN

SEVERAL PHOTOS OF ABOVE SKETCH.

VIEW LOOKING SOUTH AT 050 COOLING JOINT WITH TUBE STRUCTURES

TUBES APPEAR SOMEWHAT RECUMBENT ON PAVEMENT

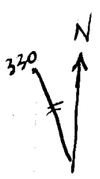
SEVERAL PHOTOS

20
8 August 1996.

ANTLER RIDGE PAVEMENT (ARP) ON N. SIDE OF ANTLER WASH

LOWER TO PERHAPS MIDDLE LITHOPHYSAL OF TIVA CANYON.

- PAVEMENT ~150m LONG, 10m WIDE.
- GHOST DANCE FAULT EXPOSED AS SEVERAL 1m+ WIDE BRECCIA ZONES. TREND 330-340 → 360 (N-S)
- NEW TRENCH CONTAINS SWARMS OF CLOSELY SPACED (DECIMETER SCALE) JOINTS TRENDING 330.



- IRREGULAR SUBHORIZONTAL JOINTS FORM METER-SCALE BENCHES IN EASTERN 50-75 m OF PAVEMENT — MAY BE DUE TO UNLOADING.

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8 August '96

ANTELOPE

- SEVERAL SMOOTH, PLANAR, MINERAL-COATED JOINTS NEAR MIDDLE PART OF EXPOSURE → POSSIBLE COOLING JOINTS.
- LOCALLY STRONG FABRIC OF CLOSELY SPACED (DECIMETER SCALE) VERTICAL JOINTS THAT TREND ~000 ARE PRESENT IN EASTERN 1/3 - 1/2 OF EXPOSURE; WESTERN PART OF EXPOSURE CONTAINS SIMILAR FRACTURE SET, HOWEVER FRACTURES TREND ~330 - 340.

- SOME CONSIDERATIONS. THE
  - THE PRESENCE OF BRECCIA ZONES AND ZONES OF INTENSE FRACTURING CONTRAST SHARPLY W/ TOPOPAH RIDGE PAVEMENT AND PAVEMENT 100.
  - ADDITIONAL DETERMINATION AT A.R.P. REGARDING ORIENTATION EARLY COOLING & TECTONIC JOINTS.

22

8 August.

- IF 330-340 AND/OR 000 JOINT SET DEVELOPED RELATED TO GHOST DANCE FAULT, THE ~ VERTICAL INTERSECTION WOULD SUGGEST STRIKE - SLIP DEFORMATION.

- IDEA
  - CONSIDER MODIFICATION OF APPROACH WITH GORDON OF SEPARATING ANISOTROPY INTO ~~SEVER~~ TWO VARIABLE COMPONENTS FOR INPUT OF FRACTURE DATA (e.g. ROSE DIAGRAM) AND STRESS-INDUCED - ANISOTROPY ASSUMPTION.

YUCCA CREST - ~~X~~cr2 & cr1 Tiva Canyon Tuff

THROCKMORTON AND VERBEEK STATION 1959 No. 1 (BENCHMARK)

~~cr~~ cr1 crystal transition subzone of the crystal rich member of the Tiva Canyon Tuff

23

8 August '96.

- Cooling joints with tubular structures.
  - 050 ~ vertical cooling joints.
  - Subhorizontal → uncommon
- NO EVIDENCE FOR REACTIVATION AS FAULTS
- NO STRONG EVIDENCE FOR TECTONIC JOINTS.
- OVERALL - DEFORMATION/FRACTURING LESS THAN THAT OBSERVED AT PAVEMENT 100 AND TONSIL RIDGE PAVEMENT.

NOTE:

IT WOULD BE USEFUL TO COMPILE A TABLE LISTING FRACTURE STUDIES (PAVEMENTS, ESF, OUTCROP STATIONS) BY ① STRATIGRAPHIC UNIT

② PROXIMITY TO A FAULT (AND WHICH FAULT).

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9 August 1996

DISCUSSIONS OF FRACTURE INVESTIGATION

D. A. FERRILL
W. M. DUNNE

TOPICS TO BE CONSIDERED FOR SUMMARY OF FRACTURE STUDIES AND GUIDELINES FOR GENERALIZING FRACTURE DATA FOR SUBSEQUENT MODELS.

- DISCUSS FRACTURE MORPHOLOGY/ORIENTATION AND GIVE GENETIC INTERPRETATIONS. CONSIDER APERTURES?
  - PLANAR w/ TUBE STRUCTURES
  - SMOOTH PLANAR CUTTING LITHOPHYSAE
  - ROUGH CURVIPLANAR ANASTOMOSING AMONGST LITHOPHYSAE
  - SUBHORIZONTAL ROUGH
  - SUBHORIZONTAL SMOOTH PLANAR.

25

9 Aug. '96.

- DISCUSS REACTIVATION
  - BRECCIATION
  - RELEASING BENDS
  - DILATION (RELATED TO BRECCIATION).
- TABULATE ~~DISCUSS~~ FRACTURE STUDIES ACCORDING TO LITHOLOGY & PROXIMITY TO FAULTS. INCLUDE:
  - PAVEMENTS
  - OUTCROPS
  - ESF.
- FLOW CHART FOR GENERATING/TESTING SYNTHETIC FRACTURE POPULATION.
  - DISCUSS POTENTIAL PROBLEMS

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9 August 1996

→ Consider renegotiating Fracman license and getting bill to run it @ U. Tennessee.

→ Anna and Waiman problems

- Probably underrepresent lengths of fractures.
- Probably doesn't account for fracture swarms.
- Does not consider fracture origin (i.e. tectonic versus cooling).

→ Ask Britt for ref's concerning lithophysae formation, w.r.t. cooling history.
- How much thermal contraction after lithophysae formation?

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(SYNTHESIZE)

The plan, to develop a dependent fracture network:

NEED -
- # of fracture sets
- PDF for orientation of each set
- PDF for fracture length in each set
- PDF for fracture spacing in each set
- PDF(?) to determine swarming (close spacing) versus non-swarming behavior. → This applies to cooling joints but may not apply to tectonic joints.
- PDF for abutting/crossing relations for fractures in different sets.
  - Cooling joints may mutually cross-cut each other

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(continued)

- Tectonic joints T2, T3 will abut against T1.
- T1 joints cross cooling joints C1, C2, & C3.
- T2 and T3 joints may abut against cooling joints
  → This will depend on aperture & cohesion of cooling joints which may have been altered by dissolution of precipitated minerals, and by dilation of joints due to shear dilation tendency within stress field.

- For vertical plane (profile) simulation, must consider vapor-plane partings and subhorizontal cooling joints.

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9 August '96

Other considerations:

- Can test synthetic by comparing comparing trace length/area from synthetic with length/area from pavement and/or ESF measurements.
- Beware of ranking joints according to abundance as was done by Throckmorton & Verbeek (Earl & Connie). As we saw at Fran Ridge pavement (2001) there were a few subhorizontal and subvertical cooling joints, but they are very long and continuous. Although they are few, they provide major fracture connectivity.
- For swarming fractures, after placement of a fracture, the probability of placing

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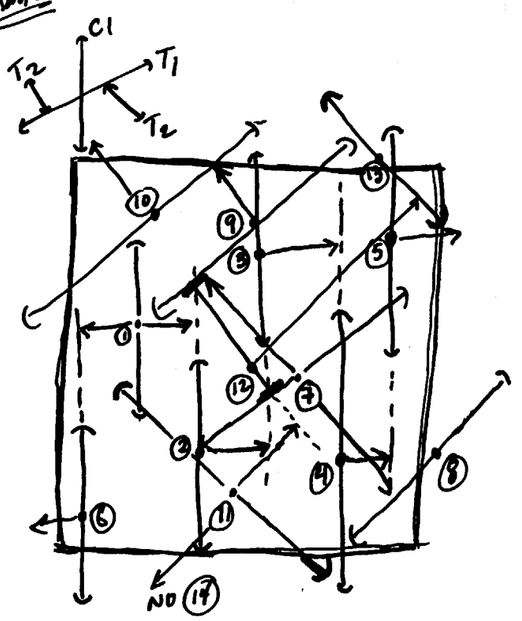
THE NEXT FEW FRACTURES WITH CLOSE SPACING WILL BE QUITE HIGH. HOWEVER, BY THE TIME 8–10 JOINTS ARE DEVELOPED, THE PROBABILITY OF WIDE SPACING FOR NEXT JOINT APPROACHES 1

EXAMPLE



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5 Nov. 1996

MAPPING FAULTS IN VOLCANIC TABLELAND NORTH OF BISHOP, CALIFORNIA.

PROJECT # 20-0750-118. ADVANCED STRUCTURAL GEOLOGY FIELD COURSE

PARTICIPANTS: D. FERRILL, ALAN MARTIN, M. CONWAY.

DATES: 3 NOV. — 9 NOV. 1996
↑ Sunday ↑ Saturday

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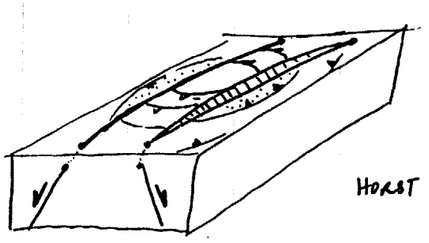
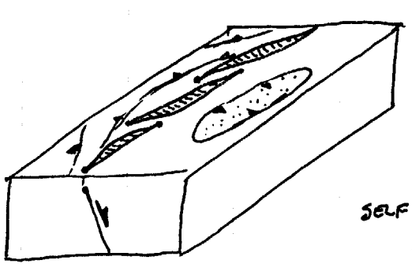
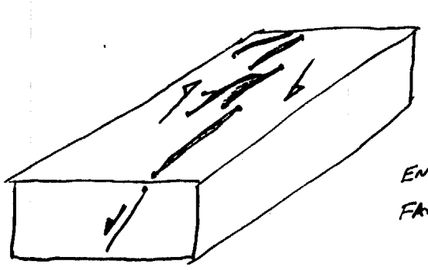
5 NOV. '96



HORST



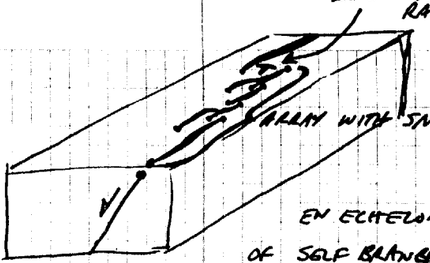
SELF BRANCHING FAULT (EN ECHELON BRANCHING)



EN ECHELON FAULT ARRAY

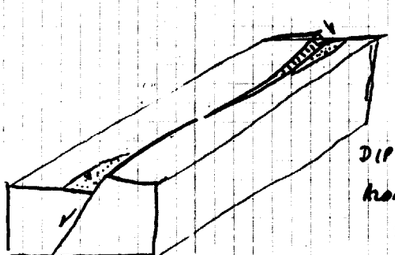
LARGER RELAY RAMPS

5 NOV '96

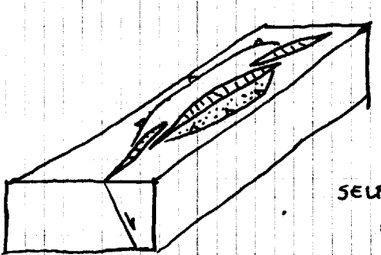


ARRAY WITH SMALL RELAY RAMPS

EN ECHELON ARRAY OF SELF BRANCHING FAULTS



DIP REVERSAL ALONG FAULT SYSTEM.



SELF BRANCHING FAULT

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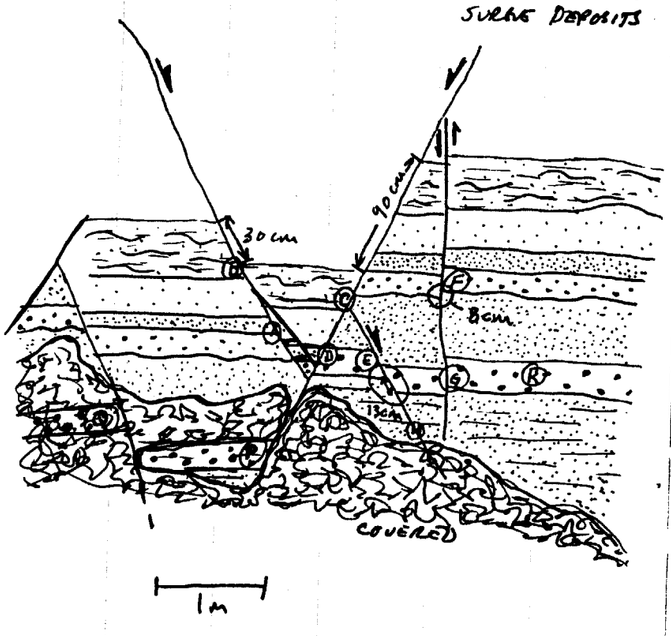
6 NW. 1996
WEDNESDAY

CHANIC BLUFF ROAD EXPOSURE:

REWORKED ASH AND AIR FALL & SURGE DEPOSITS



DECLINATION SET TO 16°.

A. ⊢ 164/69E FAULT
B. ⊢ 163/64E FAULT
C. ⊣ 172/74W FAULT
D. ⊣ 175/63W FAULT
E. ⊢ 177/69E FAULT
F. ⊣ 166/86W FAULT
G. ⊣ 163/80W FAULT
H. ⊢ 174/72E FAULT

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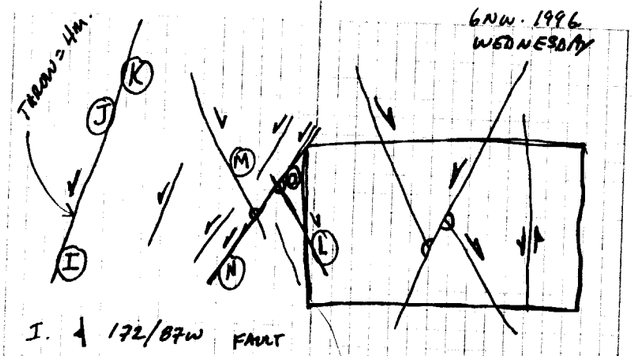
6NW. 1996
WEDNESDAY



I. ⊣ 172/87W FAULT
J. ⊣ 176/84W FAULT
K. ⊣ 180/83W FAULT
L. ⊢ 171/60E FAULT
M. ⊢ 166/67E FAULT
N. ⊣ 170/70W FAULT
O. ⊣ 169/77W FAULT
P. ⊣ 172/05W BEDDING.
Q. ⊢ 154/07W BEDDING
R. ⊕ 000/00 BEDDING, HORIZONTAL
S. ⊕ 000/00 BEDDING, HORIZONTAL.

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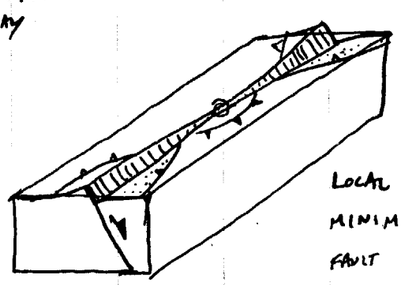
7 NW. 1996
THURSDAY



LOCAL DISPLACEMENT MINIMUM ALONG FAULT

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8 NW. '96

IDEAS FOR FIELD COURSE AND FAULT ANALYSIS OF VOLCANIC MASSIFLAND.

- CALCULATE RANGE OF RADIUS FOR THROW GRADIENT (e.g. throw/1/2 length).
- ILLUSTRATE THROW GRADIENTS FOR SOME INCOMPLETELY EXPOSED FAULTS.
  e.g. – SOLITARIO CANYON
  – FAULT SEEN FROM THE SOUTH OF RED ROCKS.
- 3D MOVE OR CONSTRUCTION MODEL OF GPS SURVEYED FAULTS IN TARGELAND
- EXTRACT KEY EXAMPLE BLOCKS FROM 3D MODEL (SEE PREV. PAGE)
- SLIP TENDENCY ANALYSIS OF FAULTS IN OWENS RIVER (CHANIC BLUFF) EXPOSURE OF UNCONSOLIDATED REWORKED AND AIR FALL TUFF.
- SLIP TENDENCY ANALYSIS OF FAULT TRACES MAPPED ON TARGELAND

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8 NOV. 96

- TURN FIELD PHOTOGRAPH OF CHALK BLUFF EXPOSURE INTO CROSS SECTION.
- RESTORE CHALK BLUFF OUTCROP CROSS SECTION.
- EMPHASIZE/ILLUSTRATE CROSS SECTIONAL STRUCTURAL STYLE AT CHALK BLUFF EXPOSURE. INTERPRET CROSS CUTTING RELATIONSHIPS.
- CONSIDER USS VS OSS VS PURE SHEAR VS OUTER ARC EXTENSION AT CHALK BLUFF.
- EXTRACT SERIAL PROFILES FROM GPS 3D MODEL FOR CORRELATION EXCERCISE.
- INTERPRET FAULTS FROM SHADED DEM (LOW RES), GPS GENERATED DEM, & SLAR (POSS. AIR PHOTOS).

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8 NOV. 96

- EVALUATE POSSIBLE TRAPS AND POSS. ROLES OF FAULTS AS BARRIERS FROM INTERPRETATIONS OF DATA OF VARIOUS RESOLUTIONS.
- KEY STRUCTURAL ELEMENTS
  - HORST
  - GRABEN
  - RELAY RAMP
  - FAULT TIP
  - THROW GRADIENT
  - SCALING PROPERTIES
  - SELF BANCHING FAULT (EN ECHELON BRANCH)
  - EN ECHELON ARRAY OF FAULTS.
  - OBLIQUE- & HIGH-ANGLE FAULT INTERSECTS.
  - FLIPPING FAULTS
  - DISPLACEMENT MAX. & MIN. (MULTIPLE) ALONG SINGLE FAULT.
  - FAULTED RELAY RAMP
  - STEPOVER FAULT.

I HAVE REVIEWED THIS NOTEBOOK AND FIND IT IN COMPLIANCE WITH QAP-001 AND THERE IS SUFFICIENT TECHNICAL INFORMATION SO THAT ANOTHER QUALIFIED INDIVIDUAL COULD REPEAT THE ACTIVITY

A. Lawrence McKeever
1/14/97

Information on Pages 178 through 189 is not U.S. Nuclear Regulatory Commission-Yucca Mountain-related information and is therefore not included in this file.

END OF SCIENTIFIC NOTEBOOK

10 May 1997

Pages 191 Through 199 Are Intentionally Left Blank

I HAVE REVIEWED THIS SCIENTIFIC NOTEBOOK (#101). AND FIND IT IS IN GENERAL COMPLIANCE WITH QAP-0.01 AND THERE IS SIGNIFICANT DATA AND TECHNICAL INFORMATION SO THAT ANOTHER INDIVIDUAL (QUALIFIED) COULD REPEAT THIS WORK, THIS NOTEBOOK HAS AN ATTACHED ENVELOPE THAT CONTAINS A COPY OF THE GEOLOGIC MAP OF BARE Mt, NYE Co. NEVADA* WITH SAMPLE LOCATION MARKER, AND A CD ROM LABELED GEOLOGY OF BARE MOUNTAIN, MONSEN ET AL., 1992 WITH SAMPLE LOCATIONS BY DAVID FERRILL (IN ARC VIEW 3.1).

A. L. McKenzie
5/7/00

* LABELED ATTACHMENT #1

ADDITIONAL INFORMATION FOR SCIENTIFIC NOTEBOOK #: 101

Document Date:	12/20/1995
Availability:	Southwest Research Institute® Center for Nuclear Waste Regulatory Analyses 6220 Culebra Road San Antonio, Texas 78228
Contact:	Southwest Research Institute® Center for Nuclear Waste Regulatory Analyses 6220 Culebra Road San Antonio, TX 78228-5166 Attn.: Director of Administration 210.522.5054
Data Sensitivity:	■"Non-Sensitive" □ Sensitive □"Non-Sensitive - Copyright" □ Sensitive - Copyright
Date Generated:	05/03/2000
Operating System: (including version number)	Windows NT
Application Used: (including version number)	Arc View, Version 3.1
Media Type: (CDs, 3 1/2, 5 1/4 disks, etc.)	1 CD
File Types: (.exe, .bat, .zip, etc.)	tfw, tif, txt, apr
Remarks: (computer runs, etc.)	Media contains: Scanned map with sample locations represents geologic bap of Bare Mountain, Nye County, Nevada (from Monsen, et al., 1992, UTM, Zone 11; NAD27 Datum