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.

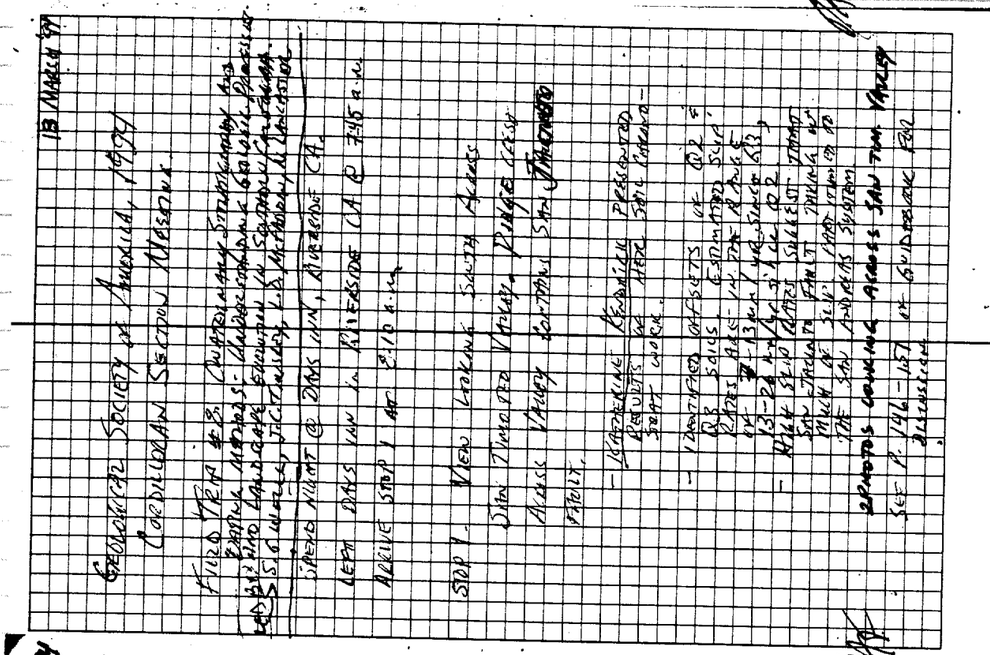
David A. Ferrill

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.



2

3/18/94

DISCUSSION IN VAN BETWEEN (UNFAMILIAR) STOPS.

DAVE RICHTMER SAYS, TODAY 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)

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(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 RAISING 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 PARTICLE DEPOSITION. (BY SHEETWASH, FLOW, WIND, ...).
- DEPOSITION MAKES YOUNG SOIL APPEAR TO BE MORE STRONGLY DEVELOPED.
- IMPORTANT TRANSITION OCCURS AT POINT OF INFLECTION ON SLOPE (TERRACE EDGE) EROSION ABOVE AND DEPOSITION BELOW.
- SOILS HERE (~~HORIZON A, B, C, ...~~) ARE TOTALLY DIFFERENT FROM TEXTBOOK DESCRIPTIONS OF SOIL HORIZONS (A, B, C, ...)

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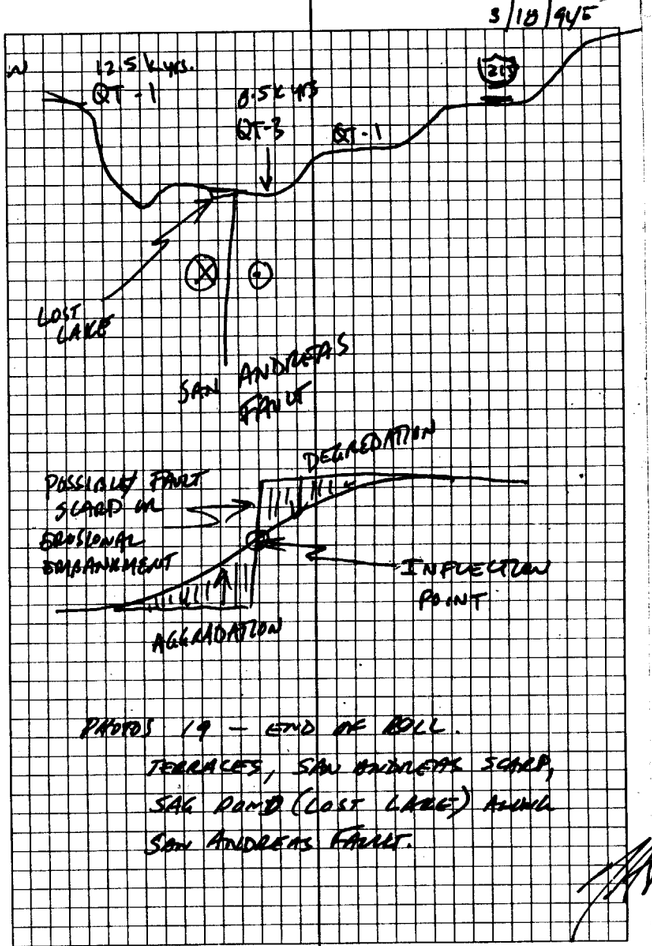


PHOTOS 19 – END OF ROLL.

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

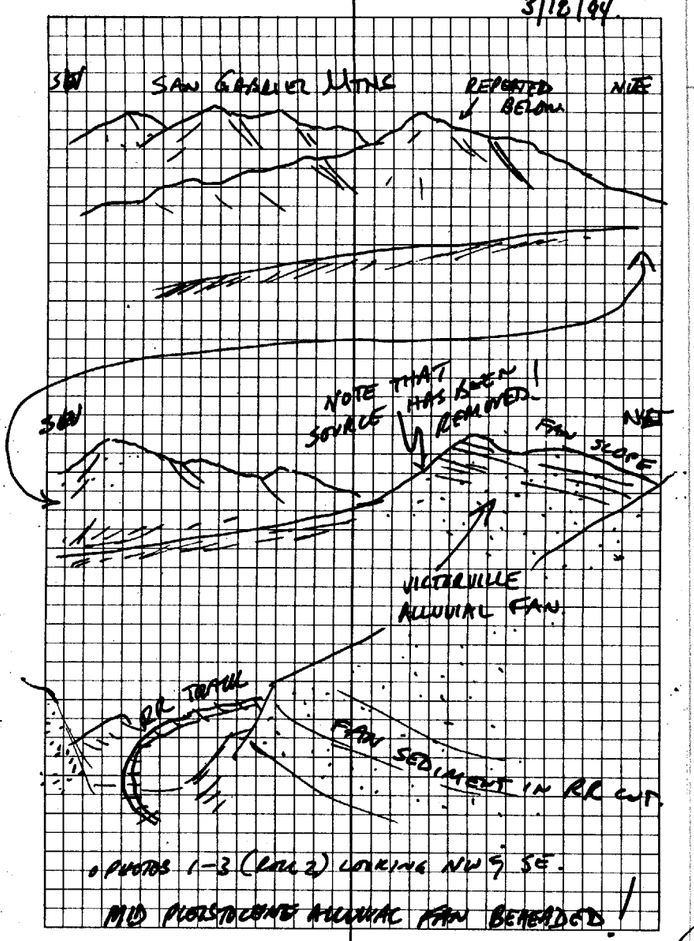
3/18/94

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 DISCUSS 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 CONTINUED 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 CALICO FAULT. CALICO MTNS. IN DISTANT BACKGROUND. VIEW LOOKING NORTH.

10 3/19/94

STOP 2.3 - SAND RAMP NEAR SITE OF FORT CADY; ~~SIGN~~ SOLDIER MTN. (ONE 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 TOP OF OUTCROP - 10-15 ka)

sand @ bottom ch. 20 kyrs

- PLEISTOCENE LAKE MANIX SAMPLING DEPOSITS ARE PRESENT AT THE BASE OF THIS SAND RAMP, ACCORDING TO NORMAN MEEKS (CAL. ST. SAN BERNARDINO) WHO DID THE PhD ON LAKE MANIX.
- STOP IS AT BENTONITE MINE
- o PHOTOS OF CROSS BEDDING IN EOLIAN SAND.
- o PHOTO'S OF SWOLLEN BENTONITE.

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.
- MANIX FAULT - 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 CINDER CONE, BLACK TANK CONE.
- o PHOTO 22 (ROLL 2) THROUGH 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 CATENA SEQUENCES.
- AGES RANGE FROM 20,000 YRS IN FUTURE TO 900,000 YRS IN PAST (20-30 MEASUREMENTS FROM LATHROP WELLS.

JOHN GOSSMAN HAS DONE PALEOMAG DATING HERE, WHICH SUGGESTS DIFFERENT AGES FOR FLOWS.

- DIFFICULT TO PIN DOWN AGES.
- BETTER TO USE SOLID FLOWS RATHER THAN BOMBS. ALSO, LIGHTNING STRIKES CONFUSE THE PALEOMAG SIGNATURE.

VAN RIDE TO STOP 2

GARLOCK FAULT INITIATED 8-12 m.y.a.

→ DAVE RICHARDS SAYS NOT. SAW McCALL'S WORK

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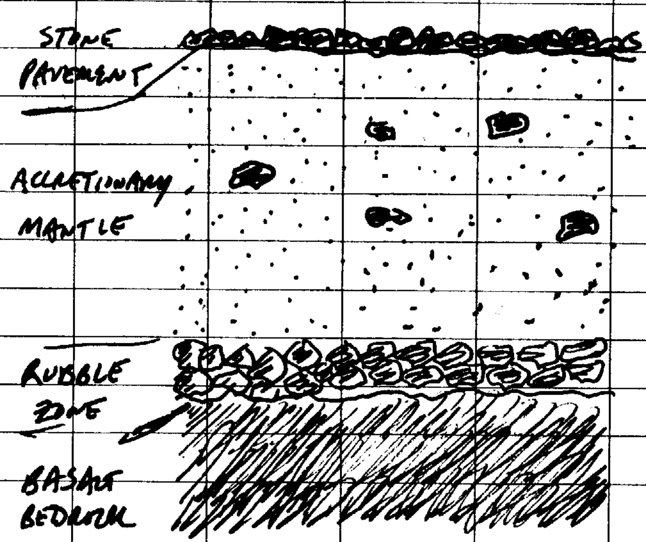
STOP 3.2 - CIMA VOLCANIC FIELD

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



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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 ALLUVIAL FANS SOURCED FROM DIFFERENT PARTS OF RANGE -

- LIMESTONE
- ~~QUARTZITES~~ GRANITIC
- METAVOLCANICS

16

3/24/94 17

LANDERS : EARTHQUAKE & AFTERSHOCKS.

3/24-25/94.

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

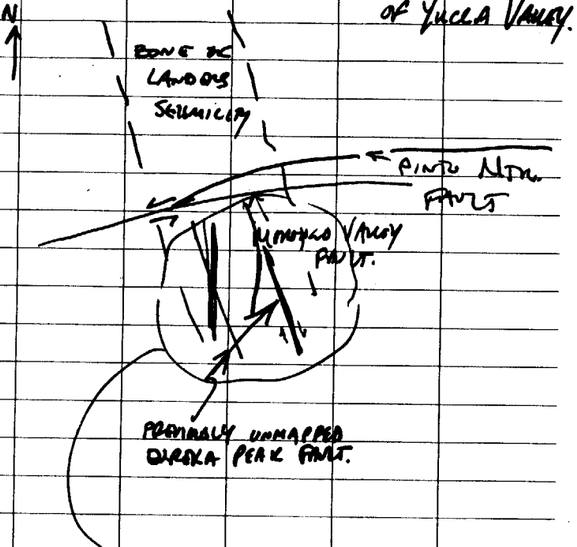
STOP 0.1 UNOFFICIAL STOP TO LOOK AT TRENCH THROUGH THRUST FAULT. SAN GORGONIO PASS FAULT (ENE TRENDING) TO ENE TIES INTO BANNING FAULT, S. BRANCH OF SAN ANDREAS FAULT.

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 F/M COUNTY TO COUNTY.
- MAP HOLOCENE FAULTS.
- BUILDING SETBACK USUALLY 50+ FT.

19 3/24/94

STOP 1 - BOULDER ALLEY IN YUCCA VALLEY - EAST WALL COLLAPSED DURING LANDERS EARTHQUAKE. (RECORDED ON TAPE RECORDER).

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

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

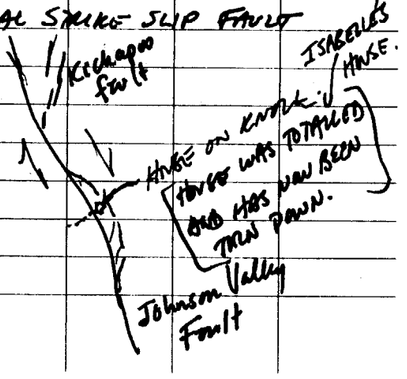
STOP 4 - HOUSE, YARD, ~~ETC~~ DEFORMED ALONG S. JOHNSON VALLEY FAULT. FAULT TREES KILLED BY FAULT CUTTING ROOTS. SURFACE RUPTURE APPARENTLY RAVELED AROUND ROOT SYSTEMS FOR FAULT TREES (STILL KILLED TREES). WATER PIPE SEPARATED, 23 FEET FROM SHED (ACTUALLY SHED SEP. FROM PIPE). EAST/WEST DIRT ROAD W.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



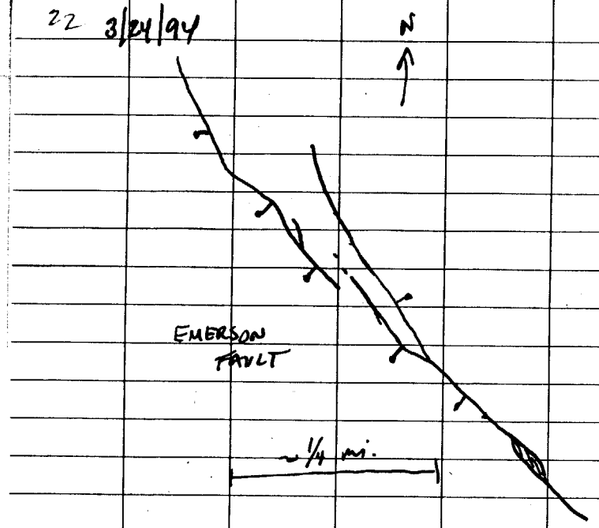
21 3/24/94

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 RELIEF OR REVERSE OBLIQUE (RIGHT LATERAL)
- FAULT PERPENDICULAR

22 3/24/94



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 (CHAP PARTICIPANT), 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 THOUGH.

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, AND CONFORMITY. 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 (STRUCTURES) 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 INSTEAD CRACK NOT ROCK ON ROADWAY 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 F/m 5 TO 2 [illegible]
- NO RFP FILED YET.
- TROUBLE GETTING PERMIT F/m BLM.
- VIBROSEIS + (DYNAMITE) EXPLOSIVE SOURCE

JOHN WHITNEY -

WINDY WASH FAULT

-
- .008 mm/yr - .016 or .017 mm/yr

QUAT. RATES -	PAINTBRUSH CANYON	.01-.02 mm/yr.
	BOW RIDGE	.001-.003
	SOL. CAN.	.01
	STAGEC. 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 CARR)

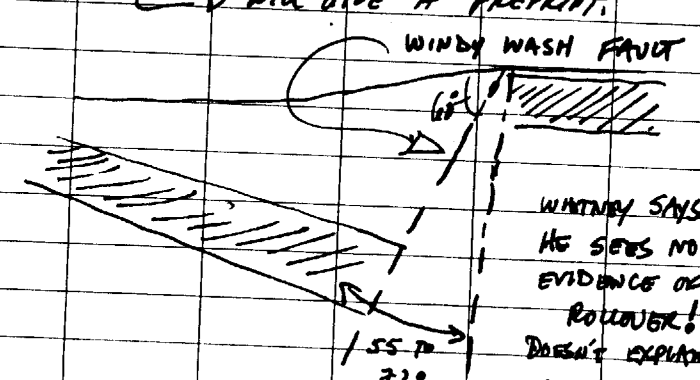
11.5 Ma - PRES. .01 - .029 mm/yr (SCOTT)

RATES ↑ F/m NW TO SE

3.7 Ma - PRESENT .03 mm/yr.

ESSENTIALLY CONSTANT RATE OVER LAST 11 Ma.

NEW FAULT MAP IN PRESS (YM). WILL BE RELEASED AS MF. → WILL GIVE A PREPRINT.



WHITNEY SAYS HE SEES NO EVIDENCE OF ROLLOVER! DOESN'T EXPLAIN HW DIP.

INTERPRETATION BASED ON SHALLOW SEISMIC.

3 May 1994 61.

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

CHRIS RAUTMAN -

- STATUS OF SYSTEMATIC DRILLING PROGRAM.
- STARTING PROGRAM (OF DRILLING 12 WELLS) WITH DRILLING SD12.
- THESE WELLS ARE IN IMMEDIATE VICINITY OF ESF

JOHN PYE

- USE OF SITE DATA IN ESF DESIGN.

CHRIS MINGUS -

- DISCUSSING FAULT STUDIES @ YM. - trenching - dating?
- BARE MTN TRENCH / → LARRY ANDERSON WILL DISCUSS IN FIELD
- BASALTIC ASH HAS BEEN FOUND IN FISSURES ALONG SOLITARIO CANYON FAULT (?) AND PAINTBRUSH CANYON FAULT?

62 3 MAY 1994 **PAINTBRUSH CANYON FAULT**

BUSTED BUTTE

430 ± 110

222 ± 10 }
146 ± 8 } U-Th
97 ± 9 }

36 ± 10 TL

STAGECOACH RD. FAULT

CENTRAL PART TRENCH SCR-T3.

87 ± 18 TL

20 ± 2 U-Th rhizoliths

108 ± 10 U-Th

23 ± 5 }
38 ± 5 } TL

↖ V. shallow - suspect sample - should be Holocene. Too old.

CENTRAL PART SCR-T3

24 ± 3 }
20 ± 2 } U-Th.

problematic → 4.9 ± 34 }
too young? 11.[illegible] }
28 ± 4 } TL

3 MAY 1994 63

→ ASHES SEEN IN SCR-T3 MAY CORRELATE W/ LATHROP WELLS EVENTS.

DISPL. MAG.

		NET DISP (cm)	CUM (cm)
PBC	MWV-T4	—	170-270
	BBUTTE	>480-590	460-580
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-T4	30-80	≤0.01
"	BUSTED BUTTE	40-100	.01-.02
BOW RIDGE	TRENCH 14D	40-80	.001-.003
SCR-	SCR-T1	10-50	.02-.04
"	SCR T3	10-50	.02-.05

FAULT	SITE	AGE MRE	ASH PRESENT
PBC	MWV-T4	1P (40-45)	NONE REC.
PBC	BB	1P (30-100)	YES II? LAYER
PBC	A1 ALICE P.	1P2	YES I-II3 [illegible]
BR	TRENCH 14D	1P (>50-85)	YES / T14 ASS
SCR	SCR T1, T3	eH Is (5-20)	YES II-III? LAY
SC	TRENCH T8 SCF-T1	1P (15-100)	YES I-II-III.

ASH LAYERS @ LATHROP WELLS.

TRENCH 8. ASH APPARENTLY NOT REWORKED - LOOKS LIKE PURE AIRFALL ASH. OTHERS PROBABLY REWORKED.

SAYS GOOD EVIDENCE HERE OF (MAYBE 2 BREAKS). ← 60-90 ka

SYNCHRONOUS FAULTING AND LATHROP WELLS ERUPTION.

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64 3 MAY 94

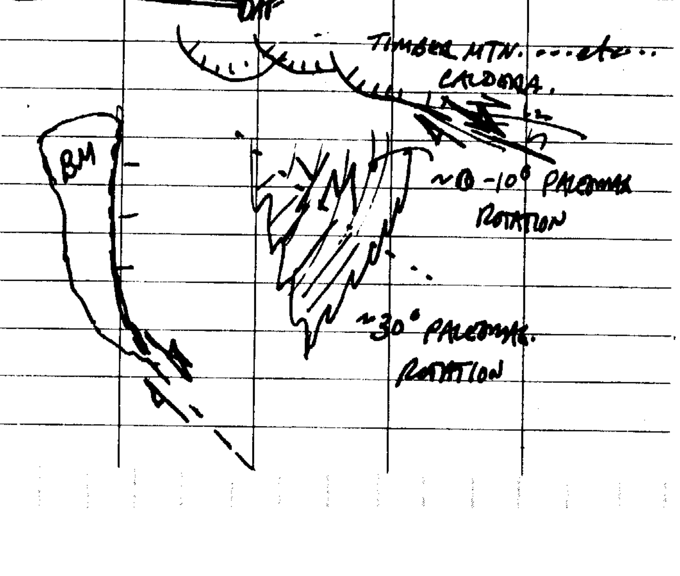
JOHN WHITNEY -

- STATUS OF MIDWAY VALLEY STUDIES.

CHRIS FRIDRICH

- SAYS SUNDANCE F. "TRIVIAL". / WE NEED TO WORK ON THIS.
- NO 3D UNDERSTANDING OF RARE MTN / YUCCA MTN FAULT SYSTEM.
- FISSION TRACK WORK (etc...) BEING DONE BY TOM HOISCH ?? @ UNIV. OF ARIZONA.
- OBLIQUE (OBLQ, NORMAL) SLIP SLICKS ON S. BARE MTN. FAULT. RL SLIP INFERRED ON NORTH YM SYSTEM BOUNDING FAULT.

~~ERNIE MAJOR~~



3 MAY 1994 65

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

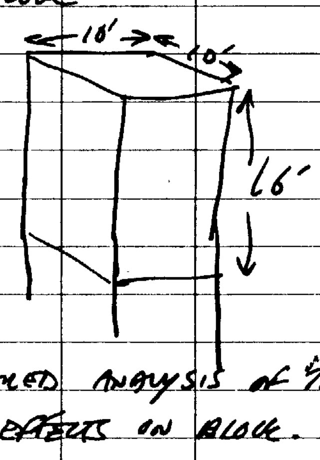
ERNIE MAJOR

66 3 May 1994

Fran Ridge - Pavement 2001 - Large Block Experiment.

Topopah Springs Tuff -
Paintbrush Gp
(Topopah Orange Brick
on Scott's 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

- Tiva Canyon Tuff in Paintbrush Gp
- Ghost Dance Fault exposed on excavated pavement - trending N-S, dipping ~85°W. w/ ~5' 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

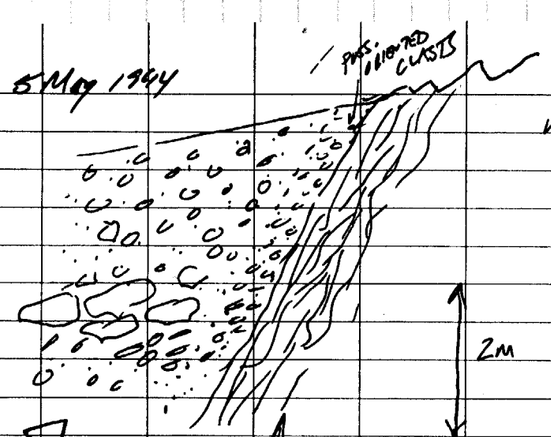
Trenches Across Bare Mtn. Fault.

Stop 1 - Meet at Steve's Pasc.

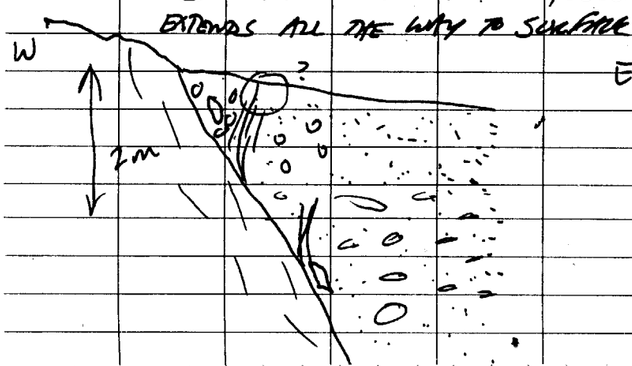
Stop 2 - Trench BMT-2. Stop led by Larry Anderson.

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

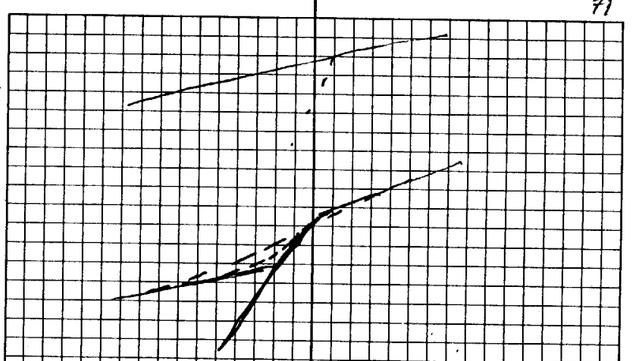
78 5 May 1994



- JOHN BELL ARGUED ADAMANTLY 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 TRAIL RIDGE CANYON. STOP LED BY LARRY ANDERSON.

- NO ABSOLUTE AGES IN TRENCH
- ARTIFACTS IN UPPER MARKER BED: MIN. AGE OF 7000 YRS
- ~~AGE~~ BASED ON SOILS - MAY BE 10-12 Ka.
- 2 NOT AFFECTED BY FAULT.

UNIT 4 -

5 May 1994

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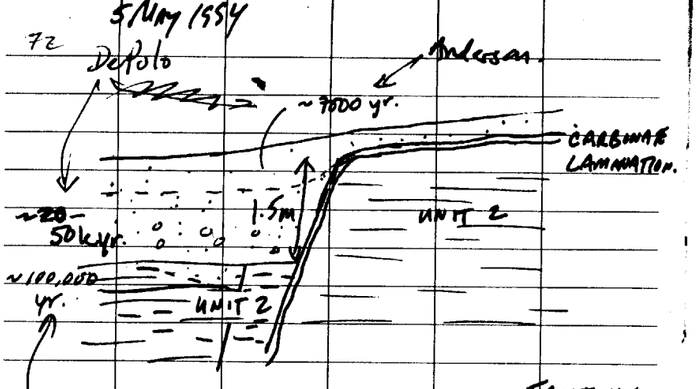


- INTERPRET ONE UNIT 2 ~~EVENT~~ FAULTING.
- CRAIG DEPOLO SUGGESTS 1.5m SLIP MAY HAVE OCCURRED SINCE B/W 20 AND 7 Kyr. IN AT LEAST 2 AND MAYBE 3 EVENTS.
- 7000 YRS BASED ON ARCHEOLOGY.

5 May 1994 73

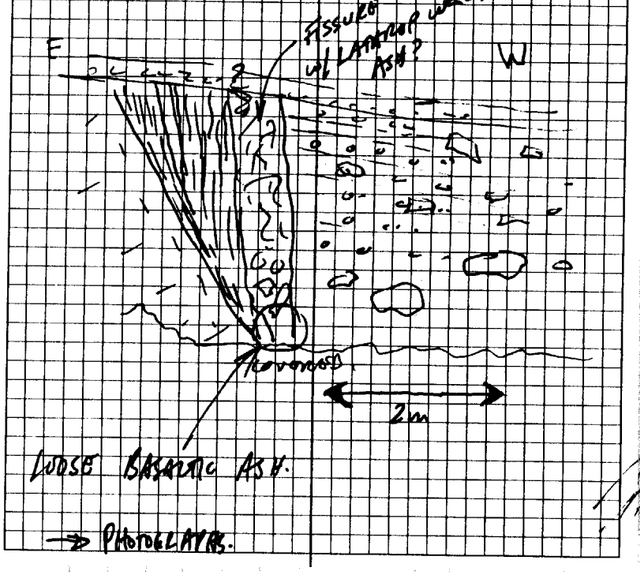
STOP 4 - SOLITARIO CANYON FAULT (TB TRENCH)

(Alan Ramelli)

10 Ka to 200,000 yrs - 4 events - 2 m displacement

→ .01 mm/yr

RECURRENCE 40-50 K yrs.



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.

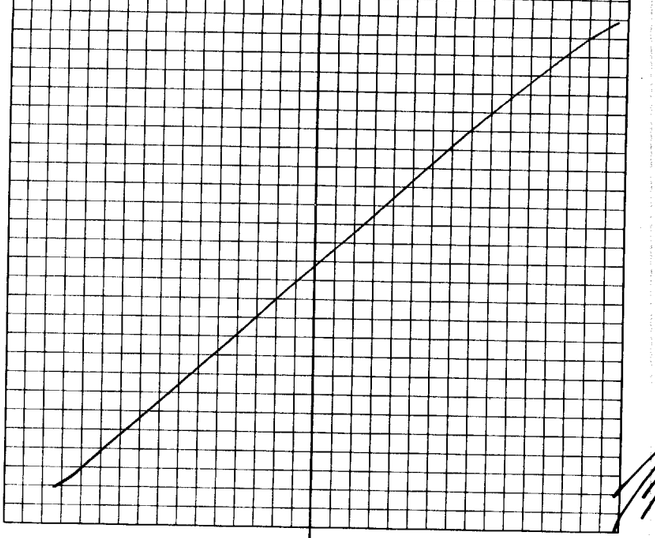
WALK F/M SCF-T3 TO SCF-T1A

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

5 MAY 1994 75

TRENCH SCF-T1A -

- RECENTLY DOC'D, A.R. LOCATION
- INTERESTING STRATIGRAPHIC CHANNEL-FILL 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 HAMLS 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 HOOKED N. AT TUB RANCH, DRIVING PARALLEL TO E (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 ON THE KAIBAB LIMESTONE.
  → THIS IS IN CONTRAST TO MY INTERPRETATION, FROM AIR PHOTOS, THAT THE CEDAR RANCH FAULT CUTS THE Qmb FLOW.

SUGGESTS TIMING OF LAST MAJOR MOVEMENT ON CEDAR RANCH FAULT is/on 1.38 AND/OR 1.04 MY.

6609

- 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.

79 8/15/94

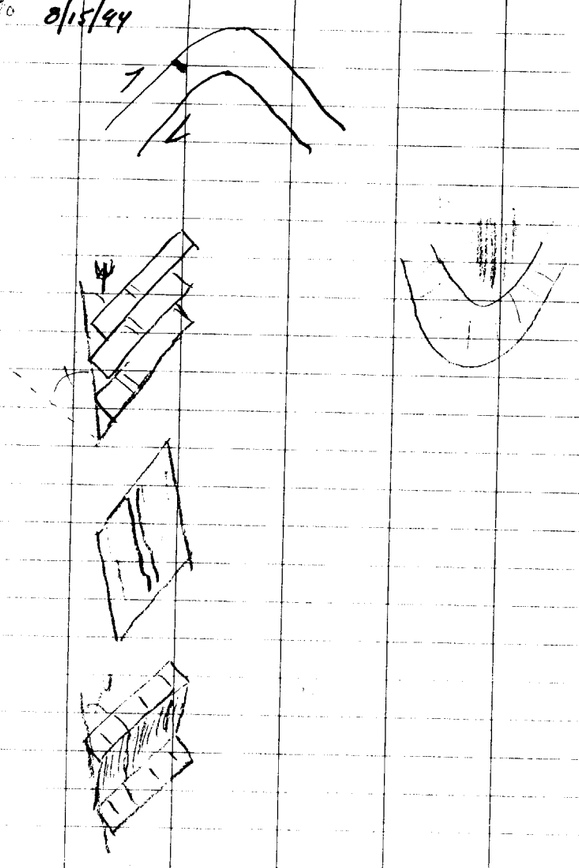
MESA BUTTE CINDER CONE (CONT'D)

- 054/37NW ← IRREGULAR SPATTER SURFACE ON SE SIDE OF BREACH ON NE END OF CONE. SEEMS TO BE IN PLACE, BUT STILL QUITE STEEP.
- 042/48NW

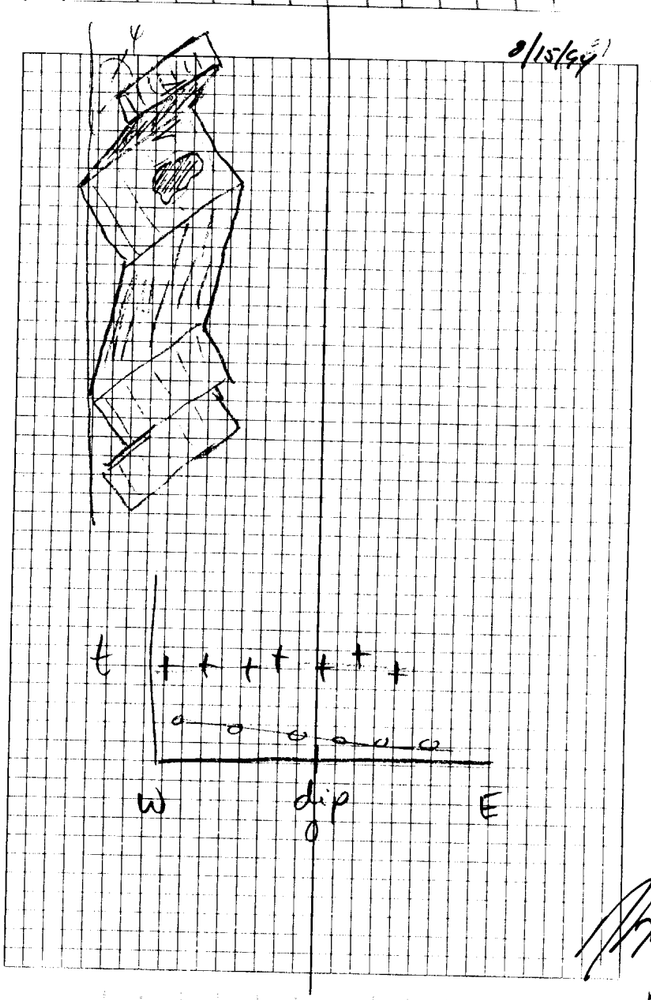
→ UNCERTAIN RELATIONSHIP OF CONSTRUCTIONAL SPATTER TO SLOPE ON "BREACHED" (?) NE END OF M.B. CINDER CONE

- SPATTER WALL IN CENTER OF M.B. CINDER CONE DOES NOT APPEAR TO BE CUT BY FAULT.
- SPATTER WALL SAMPLED, FOR CHEMICAL COMPOSITION AND ROCK 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 NEAR VENT TO NE (V6604) FOR EVIDENCE FOR OR AGAINST FAULTING.

60 8/15/94



81 8/15/94



82 8/15/94

16 AUGUST 1994

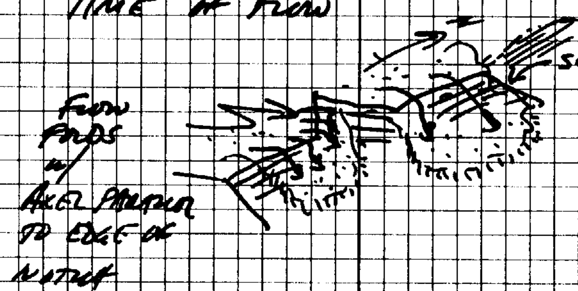
- DROVE IN TO CEDAR RANCH FAULT VIA SAME ROUTE AS YESTERDAY

STOP 1

- PARKED ALONG ROAD ADJACENT TO SOUTHERN EXPOSURE OF Pka/Pkb. ~~AND~~ 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 MAREAS.
- TOOK MANY PHOTOGRAPHS DOCUMENTING FLOW NEAR EDGE OF FAULT (LINE?) SCARP.
- FLOW FOLDS ALONG MARGIN OF SMALL EXPOSURE (S. SIDE) OF Pka/Pkb.

8/15/94 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 NEAR EDGE OF SCARP AT N. END OF ~½ mi LONG CONTINUOUS EXPOSURE OF Pk.
- Qmbf FLOW HAS EASTERN TERMINATION AT N. END OF CARBONATE EXPOSURE.

84 8/16/94

- SOUTHERN Qmbf EXPOSED FLOW (SEC. 15) IS MAPPED TO BE IN CONTACT w/ Pk, HOWEVER, WE SAW NO EVIDENCE OF THIS. Qmbf APPEARS TO OVERLY Qmb.
- Qmbf 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 THEREIN.
- NORTHERN Qmbf FLOW AT SOUTHERN PART OF BOUNDARY BETWEEN SEC 9 & SEC. 10 IS A MORE CONVINCING 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 BUTTE CONE APPEAR TO BE RELATIVELY COMPLEX. NORTHERNMOST RIDGE (V. SMALL RIDGE) SE OF MESA BUTTE CONE MAY BE SMALL FLOW. BROKEN UP VESICULAR 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 ALONG Qmb RIDGE TO COLLECT STRIKES AND DIPS. TOPOGRAPHIC EXPRESSION OF 2 FAULTS MAPPED IN Pka IS DISCERNIBLE ON SURFACE, HOWEVER FAULTS DO NOT ACTUALLY SEEN.

→ RETURNED TO CAR AND HEADED FOR FLAGSTAFF.

86 8/17/94

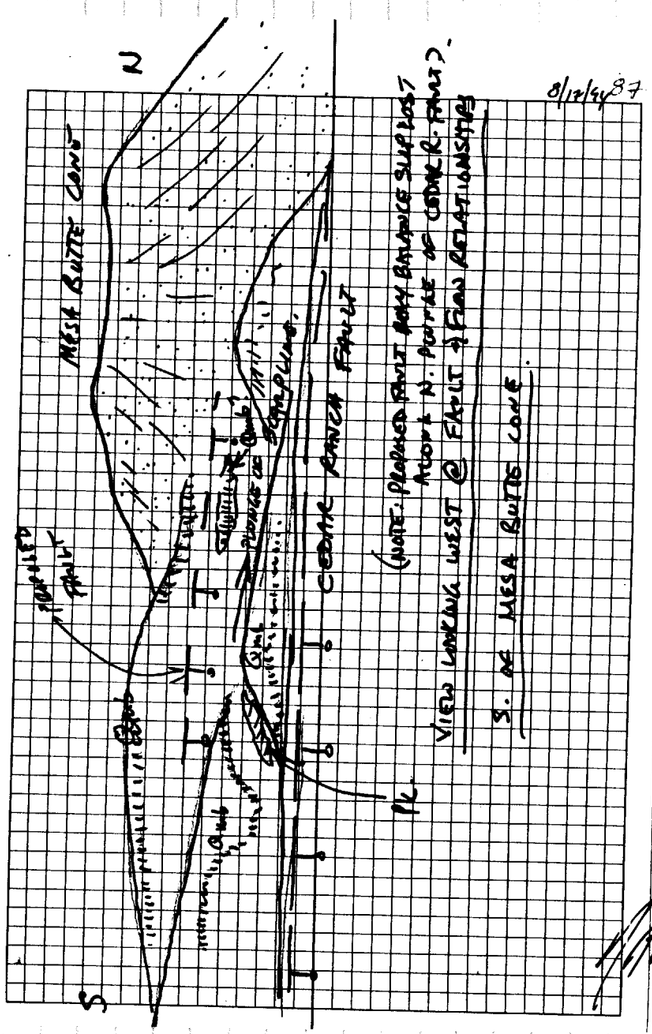
17 AUGUST 1994

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 REGD. - "VULCAN CONE"
  - MESA BUTTE CONE/CEDAR RANCH FAULT

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



88 8/17/94

- DRIVE NE FROM MESA BUTTE CONE ALONG EAST RIM OF ADDITIONAL HOLE MONOCLINE, NOTE CONTACT W/ 6607 Qmb. COLLECTED STRIKES AND DIPS ALONG MONOCLINE (ADDITIONAL HILL), INCLUDING MOSTLY CONSTANT EASTWARD DIPS, NE STRIKES. HOWEVER, NW DIP OF SEVERAL DEGREES MEASURED AT NW EDGE MONOCLINE, NORTHEAST MESA BUTTE-FAULT. COLLECTED STRIKE + DIPS FROM NW SIDE OF FAULT TO EDGE OF ESCARPMENT. ALAN MARKS CONTINUED ORIENT. ALONG IN HIS NOTEBOOK.

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

- DRIVE UP ROAD B/W MESA BUTTE CONE AND VENT 6604 CONE AND PARALLEL SEV ALONG POWERLINE (3 PHASE)

8/17/94 89

ROAD, COLLECTING ORIENTATIONS OF BEDDING IN PK.

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

- ASCENDED NW FLANK OF V 6604 CONE AND INTO SPATTER CHARNOCK. SPATTER CHARNOCK VISIBLE ON FACES ON OTHER SIDE OF CENTRAL VALLEY OF CONE, INDICATING THAT VALLEY ALONG FAULT THROUGH CENTER OF CONE WAS PRIMARY CONTINUATION OF SOURCE RATHER THAN PRODUCT OF SUBSEQUENT FAULTING AND EROSION. TOOK ADDITIONAL PHOTOS THERE.

- WALKED N. ALONG Qmb 6604 FLOW TO BE SCARP-NORMAL CANYON CUTS INTO PK AND Qmb. NORMAL AND REVERSE FAULT VISIBLE ON N. CANYON WALL (IN LIMESTONES AND APPARENTLY NOT CUTTING 6604 Qmb FLOW.

90 8/17/94

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

→ DROVE BACK WEST 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.

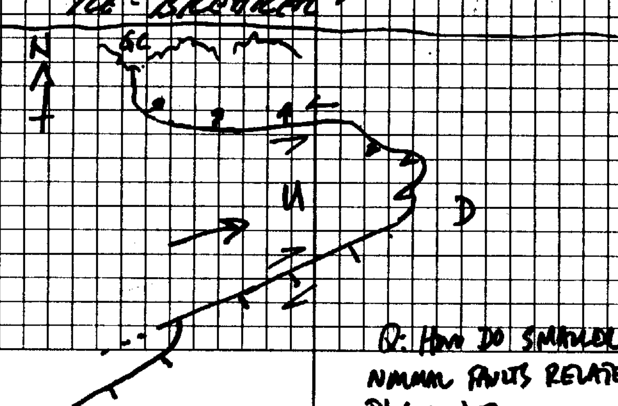
- FOLLOWED (64) ALONG CANYON TO GRANDVIEW POINT. TOOK PHOTOS OF CANYON INCLUDING INTERSECTION OF KAIBAB MONOCLINE AND CANYON, EAST OF POINT. SUNSET

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

8/17/94 91

@ NW "BEND" OF MONOCLINE.
- AT BEND, 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 & ABUNDANT 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 CAPPING CARBONATES ALONG EDGE OF CEDAR RANCH FAULT LINE SCARP.

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

- INVESTIGATING Qub F (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, EVEN W/I 300 M OF THE SURFACE. BUT, THIS IS OF COURSE STRONGLY DEPENDENT OF FAULT GEOMETRY, WHICH WE DO NOT YET KNOW.

- Qub F HAS MASSIVE UNIT AT BASE OF EXPOSURE, OVERLAIN BY MORE VESICULAR BASALT. MASSIVE BASALT SAMPLED FOR AGE DATE.

→ HEADED SE ACROSS VALLEY TO APPARENTLY INTRUSIVE Qub 6609 (SE ¼ SEC 3 T26N R6E & NE ¼ SEC. 10).
  - STRONG FABRIC PARALLELING TREND OF OUTCROP (INTRUDED FAULT) AND DIPPING STEEPLY WESTWARD.
  - FRAGMENTAL VESICULAR LAYERS INTERLAYERED

WITH MASSIVE UNITS w/ FABRIC. TEXTURE AND OUTCROP FABRIC SUGGESTIVE OF FISSURE DEPOSIT.

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

→ PROCEEDED NORTHEASTWARD ALONG PRESUMED 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.

• 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 PLEA, WEST OF ROAD.
– COLLECTED SAMPLES OF 6609 QUB 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 PLEA.
– COLLECTED 6609 QUB SAMPLES FOR AGE DATING AND CHEM. ANALYSES FROM VOLCANIC OUTCROP AT BORDER B/W SEC 13 & SEC 24.

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 DOLANEY ABOUT PROJECT ON MESA BUTTE FAULT.
– GAVE US REFERENCES ON KAIBAB MONOCLINE BY IVAN REYNOLDS.

– 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 TOM & BRITT ABOUT THIS.

5 OCTOBER 1994

VOLCANISM PEER REVIEW FIELD TRIP

PARTICIPANTS:

CNWRA: CHUCK CONNOR
BRITT HILL
GERRY STIRNWALT
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

<u>LATHROP WELLS CINDER CONE</u>

<u>DISCUSSIONS</u>

- CRATER SLOPES MUCH LOWER THAN ANGLE OF REPOSE
- EOLIAN INFLATION (DUST BENEATH CINDERS) VERY WELL DEVELOPED
- NO EVIDENCE OF FAULTING 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 STROMBOLIAN 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 10K 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 <u>INSTEAD</u> RAFTED BLOCKS OF CINDER CONE THAT SLUMPED, LIKELY IN A SINGLE EVENT (~~E~~) (THERE IS NOT PARTICULARLY GOOD EVIDENCE THAT THERE ARE NUMEROUS ERUPTIONS MARKED BY SCORIA MOUNDS @ VENTS).

* • WALKER, ~~I~~SELF, LIPMAN, etc... SUGGEST SAMPLING ASH

5 OCT. 94.

FALL DEPOSITS AND PERFORMING TEXTURAL ANALYSES 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. ~~THE~~ 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 '94 101

- 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 QUARTZ SAND. SMALL PUMICE FRAGMENTS COMMON INTERLAYERED W/ SAND SIZED ~~FR~~ LAMINAE.
- "SCORIA MOUNDS" (LAST STOP OF DAY) CONSENSUS 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/I CLASTS INDICATIVE OF VISCOSITY.
HIGHER VISC.? → • HERE, DOUBLING OF VESICLE SIZE EVERY 2CM OR SO.
MAYBE 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
NORTH OF ROME → 2800 YR! & IN ROME
ASSOC. W/ ETRUSCAN CIV. (CAN SEE ROMAN) → OLD TUNNELS IN ASH FLOW TUFFS. STABLE IN SEISMICALLY QUAT. ACTIVE AREA (M 7+ EQ 20 YRS AGO). DRY!
SMALLER THAN REPOSITORY SCALE.
• EARLY CHRISTIANS → CATACOMBS. (~30 A.D.)

PETER LIPMAN –

→ CAPPADOCIA – ANATOLIA TURKEY
NAT. GEO. [illegible] CAVES DUG OUT & LIVED IN EXTENSIVELY.
ALSO GRANT HEIKEN WROTE POPULAR ARTICLE ASH FLOW TUFFS (QUAT) 400 – 1200 A.D.

→ ARMENIA ALSO HAS TUNNELS.

104 6 Oct. '94.

ETRUSCANS –

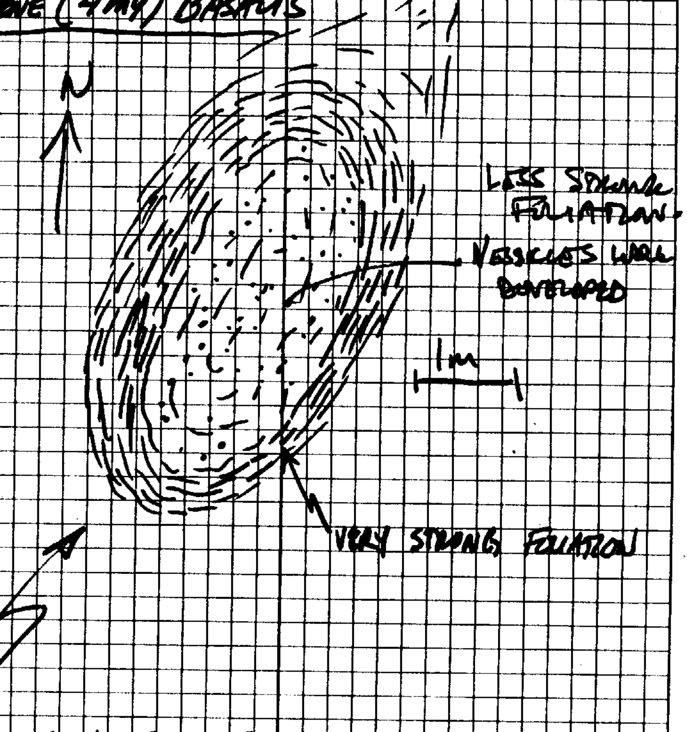
* BEAUTIFUL WALL PAINTINGS WELL PRESERVED.
* CAREFULLY HID TREASURES IN TUNNELS. STILL OCCASIONALLY FIND TREASURES.

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 ID'D ALONG FAULT SURFACE – WEATHERING TO FORM QUITE SIMILAR LOOKING MATERIAL

6 Oct. '94 105

PLIOCENE (4MY) 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.

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Notes made in evening @ Furnace Creek Steakhouse.

△ Need to contact Paul Delaney to remind him to send me 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 these faults (no strong evidence.

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Lipman mentioned slickenlines on Solitario Canyon Fault as evidence for S.S. This is generally not too convincing of an argument.

Ruppman → mentioned having seen lots of low angle fault(s) in Calico Hills, ~~Feels that Fr...~~ seems to feel that Frizzell & S[illegible] 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.

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Notes from Bare Mtn Map.
Monsen, Carr, Reheis, & Orkild.
1992

- Oav - Antelope Valley Fm of Pogonip Grp supposed to contain c.g. LS.

Oav 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 Oav adjacent to other faults to south of Tarantula Canyon.

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→ 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 adjacent to and away from faults.

→ Sample others as at and away from faults.

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TECTONICS RESEARCH FIELD WORK AT BARE MTN., NEVADA

DAY 1

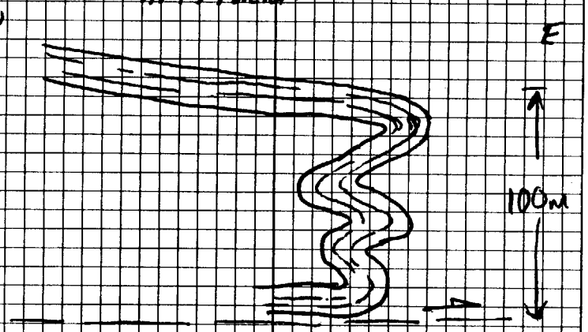
- LEFT BEATTY, NV AND DRIVE EAST UP FLORISPAR CANYON.
- STOPPED TO STUDY CARBONATES SILL ARE SURROUNDED BY CAMBRIAN CARBONATES. (MAINLY DOLOMITE).
- STUDIED ARKOSIC ARENITE IN DOLOMITE AND LIMESTONE IN FOOTWALL OF DETACHMENT FAULT.
  - STRONG PENETRATIVE GRAIN SCALE FOLIATION CUT BY N-S SUBVERTICAL EXTENSION VEINS.
  - LIMESTONE AND DOLOMITE PRESENT.

7 Oct. '94 111

- TAFF IN HW ARE BRITTLE FABRIC - DEFORMATION INTENSITY V. LOW COMPARED W/ CARBONATES IN FOOTWALL.

→ GOOD PLACE TO STUDY FAULT ROCK FABRICS IN PHYLLOSILICATE AND HORNFELSIC.

WEST OF SPECIE SPRINGS - RECUMBENT NNE FOLD.



FOLD IN Ord (Ordovician Nidemile) IN TARANTULA CANYON

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DEVONIAN

TARANTULA FORMATION BETWEEN SPECIE SPRING AND BARE MTN FAULT.

- BOULDER CONGLOMERATE CARBONATE CLASTS 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 FOLD DEFORMATION EVENT STHAN OLDER CARBONATES.

7 Oct. 94 113

MIOCENE DIKE NEAR BM FAULT @ E END TARANTULA CANYON.

→ BEST EXPOSED EXAMPLE ALREADY SAMPLED. PROBABLY BY SQUEEGEERITE STUDENT.

→ LEFT SAMPLE UNMARKED DIKE TO SHUT.

114 8 OCTOBER 1994 (SATURDAY)

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

- Benny Stewart joined group, he is planning to be with us today and Sunday. Will return to Washington, DC on Monday.

1ST STOP. CARBONATES SOUTH OF STEWART PASS.

→ FOUND 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 WALKED 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	CLEAVAGE
075/67S(OT)?	040/46S
058/48S(OT)?	054/41S
068/51S(OT)?	040/50E
068/58 S(OT)?	

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

BEDDING	CLEAVAGE
077/85S	046/50E
091/85S	032/54E
074/80S	

JOINTS

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

→ LUNCH @ THIS STOP.

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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 W 50 M FROM UNMAPPED DIORITE DIKE.

050/80NW
060/84NW

DF BM5 - DIORITE DIKE SAMPLES

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

117

DFBM5 sq1
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
• 8.4m from NW EDGE OF DIKE; 1.6m from SW EDGE

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

DFBM5 sq2
STERLING QUARTZITE w/i 5cm OF NW CONTACT W/ DIKE

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

DFBM6 - STERLING QUARTZITE
γ 064/79W BEDDING
γ 062/65W BEDDING.
γ 031/63W CLEAVAGE

→ WHILE STEVE & I SAMPLED HERE - THE REST OF THE GROUP DRIVED CURVES WE MAPPED DIAGONAL DIORITE DIKE @ STREAM VALLEY.

→ JOHN & ALAN HIKED UP TO HAND SAMPLE FURNACE ENE ALONG DIKE.

** RETURNED TO BIRD TAIL. QUICKLY CHANGED & DROVE TO ZABRISKIE PT. AND TO FURNACE CR. RANCH FOR SUPPER

8 OCT. '94. 119

IDEAS FROM THE DAY -

1. TO CONSTRAIN TIMING OF UPLIFT WITH RESPECT TO DIKE INTRUSION (WHICH IS DATABLE), COMPARE FISSION TRACKS IN QTZITE IMMEDIATELY ADJACENT TO DIKE WITH QTZITE OUTSIDE OF CONTACT ZONE. IF COOLING THROUGH FISSION TRACK ANNEAL T PRECEDED INTRUSION, THEN GRAINS ADJACENT TO INTRUSION WILL BE ANNEALED AND SHOULD RECORD LATER "UPLIFT" TIMING. IF INTRUSION PRECEDED COOLING THROUGH CLOSURE T, THEN UPLIFT TIMING WILL BE SAME W/O REGARD TO POSITION WRT DIKE.

→ SAMPLED STERLING QUARTZITE @ DFBM5 TO TRY THIS OUT.

8 OCTOBER 1995.

2. SAMPLE TERTIARY TUFFS FROM NEARLY CONTINUOUS SECTIONS W/I FAULT BLOCKS - ROTATION AT NORTH END OF BLACK MTN.

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

9 OCT. '94 121

DAY 3 OF TECTONICS FIELD RESEARCH

STOP 1. WEST END OF FLORSPAR CANYON - COLLECTING CRETACEOUS DIKE AND SURROUNDING DOLOMITE FOR P'MAG.

COLLECTING CARBONATES APPROACHING FAULT ZONE & TUFF IN HANGINGWALL TO STUDY DEFORMATION MECHANISMS.

DFBM7 @ PAPOOSE LAKE MEMBER OF CAMBRIAN BONANZA KING FM.

MEDIUM GRAY DOLOMITE SAMPLED 5 M BELOW DETACHMENT FAULT.

→ 090/60N MEASURED ON WEATHERED SURFACE. BEDDING INDIST - (ILLEGIBLE) ...

122. 9 Oct. 94

DFBM7b - Tr. Middle Miocene "rhyolite lava"
→ Lower Ridge Gray Tuff.

^{45} 089 — 089/45N measured on fracture surface.
→ Bedding orientation unknown.
→ Sample from 5m above detachment fault.

→ Less dense unit immediately above sampled unit weathers to angular fragments < 1 cm
• Extremely abundant slickensided fracture surfaces

DFBM8 - Ttmr
→ Red Ranch Mesa Tuff sampled immediately adjacent to fault surface.

9 Oct 94 123

055 75SE 18 — Fault orientation 055/75SE. Slickensides rake 18° SW.

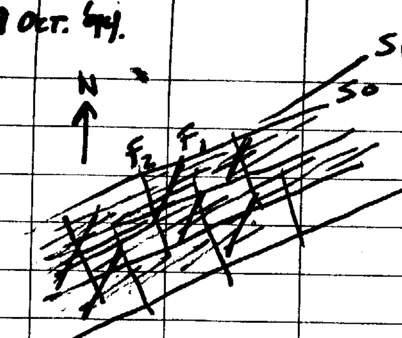
078 77SE — Orientation on fault surface. (Sample DFBM8)

Sample from ~30 m above detachment surface (estimated normal to detachment surface).

DFBM9 - Papoose Lake Mbr of Bonanza King Fm

S_0	072/90	Bedding
S_1	065/88NW	Cleavage
F_1	029/83E	Veins (poss. faults) which appear to cut cleavage

9 Oct. 94.
124



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 32SE — 062/32SE layering
087 40 — 087/40SE layering

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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 limestone is very complex. Might be worth working on later, after studying crosscutting relationships in thin section.

DFBM10 - Papoose Lake Mbr of Bonanza King Fm.
Thinly ~~bedded~~ interbedded limestone & qtzite (1-3 cm).
Bedding clearly visible. Qtzite weathers in positive relief.
079/68NW Bedding

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SAMPLES DFBM10 - Intermingled LST & Qtzite
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 INTRUDED QTZITE. (UNMAPPED BY MASON et al.)

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

SAMPLE FOR FISSION TRACK ANALYSIS.
→ Zwld. Unit D of Lower Mbr of Proterozoic Wood Canyon Fm.
DFBM11a
061/30N ORIENTATION ON BEDDING

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101/27N BEDDING

145/70E UPPER DIKE CONTACT.

131/38NE BEDDING.

(DFBM11b.
045/60N orientation on ~~fracture~~ BEDDING surface.)
← UNABLE TO RECOVER THIS SAMPLE.

DFBM11c DIKE SAMPLED ~ 1m below upper edge boundary with Quartzite

DFBM12
NOTE: ANOTHER DIORITIC DIKE ~ 100m SW OF DFBM11,
ALSO, APPEARS TO BE ANOTHER ACROSS GULLY (~ ~~DFBM13~~ NNW) (CONFIRMED BY VISIT)

DFBM13 ← FROM TOP OF HILL IT APPEARS THAT DFBM12 & 13 MAY BE SAME
DIKE TO N OF DFBM12 CONFIRMED BY VISIT. (INTRUDES CARBONATE ROCKS:). ESTIMATED STRIKE OF DIKE 020-030

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DFBM14 - DOLOMITE OF Ɛpp @ RIDGE CREST. COMPOSITIONAL LAYERING (BDG) QUITE VISIBLE).

60N
080 BEDDING 080/60N ON BOTTOM OF BDG PLANE.

125/50N BEDDING @ SAME OUTCROP.

NOTE: INFERRED N/S FAULT BETWEEN STATIONS DFBM 9 & DFBM14.

DFBM15 - Temp
Same 200-300m east of DFBM8

105/73S
SLICKENSIDES RAKE @ 16° SW.
186/79S
SLICKS RAKE @ 27° SW.

10 Oct. 94 129.

DAY 4 OF TECTONICS FIELD WORK @ BARE MTN. NEVADA

STOP 1. DFBM16 - Zabriskie Quartzite. (Sample for Fission tracks).
163/33E
151/35E } Bedding
(NOTE: PHOTOS FROM RIDGE DUE EAST OF SAMPLE)

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

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

NOTE: LIMESTONE GOAT SAMPLES HAVE FOSSIL HASH LAYERS THAT RECORD VERY LOW GRAIN-SCALE STRAIN. EXTENSION VEINS IN 11 SETS & EN ECHELON ARRAYS

130 10 Oct. 94

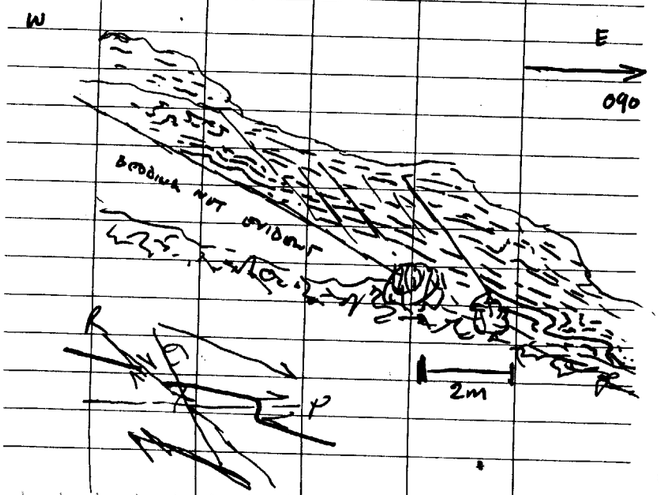
DFBM19 - Eureka Quartzite.

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

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

DFBM20 - Ogs - Ordovician Fly Spring.

• PHOTOS TAKEN HERE



10/Oct. '94. 131

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

X 145/35E BEDDING.

DFBM20a X 144/30 NE } NOT BEDDING!
DFBM20b X 157/48 NE } all on veined
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 (SNOW CAPPED). 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 Yucca Pass + T.M. Canyon in distance.

DIKE 10 M WIDE

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

Ebbl
- DFBM22.5 010/80 OT = 010/100 } IMMEDIATELY ADJACENT TO WEST DIKE MARGIN.
- DFBM22.6 090/59N } 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 067/87NW ? }
- — 083/66N } BEDDING
- — 083/67N }

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

DFBM25 - End

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

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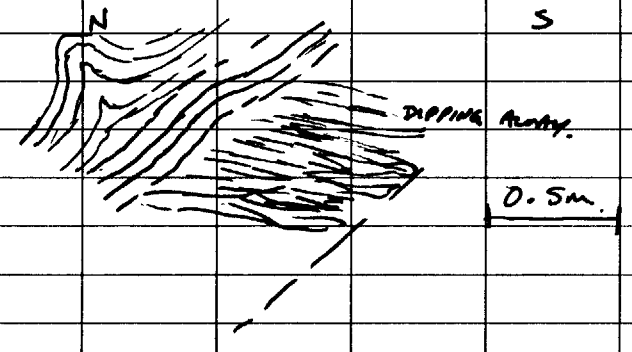

Slightly metamorphosed shale (sounds like walking on glass) which contains graptolites and framboidal (?) pyrite. Neither show significant strain in hand sample. Disharmonic mesoscopic folding is present.

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

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DFBM26 - Ebbl

067/60 N Bedding (Measurements from
070/50N Bedding (samples 4 & 3.)

DFBM26.1	140/78	on fracture surface
DFBM26.2	125/25	on fracture surface
DFBM26.3	070/140	(underside bedding)
DFBM26.4	067/150	(underside bedding)

DFBM27

~~[illegible]~~
~~[illegible]~~
063/45NW → Bedding

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

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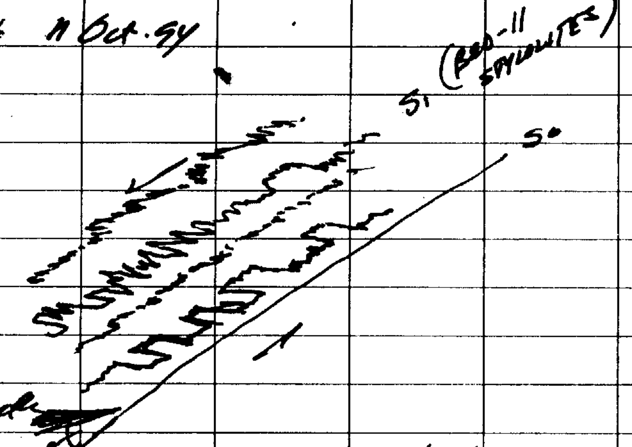

Stylolite teeth @ ~30° to bedding. Geometry indicates (suggests) top to N shear. ↑ bedding dip.

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, DFBM?, which was used to interpret overturned bedding.

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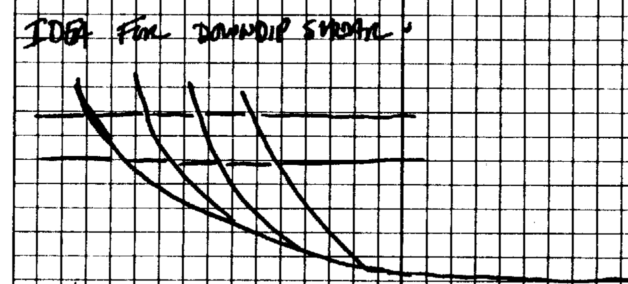
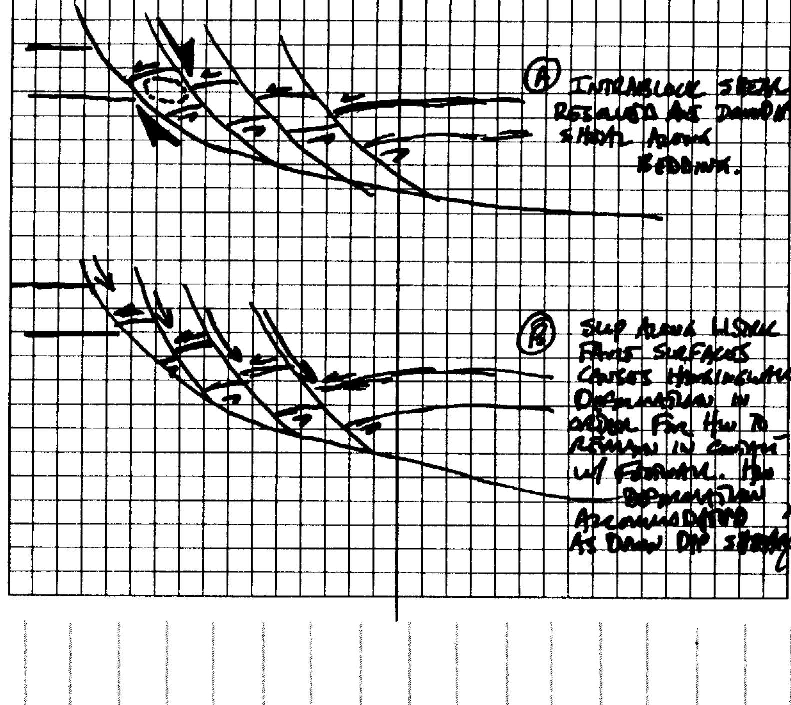
NOTE: Late mesoscopic faults @ high angle to bedding sometimes offset sheared stylolites.

IDEA for downdip shear.





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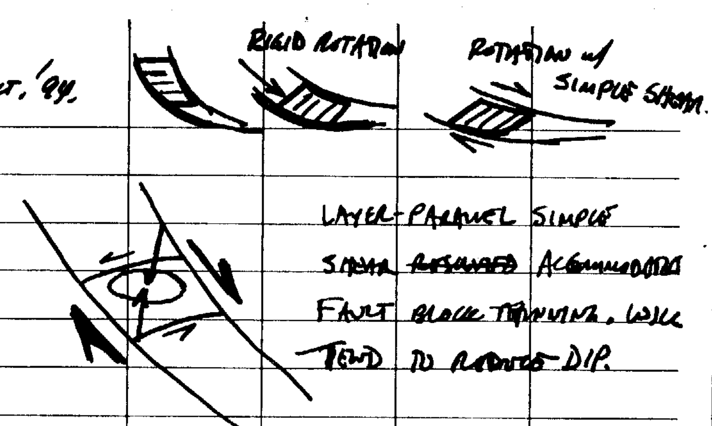
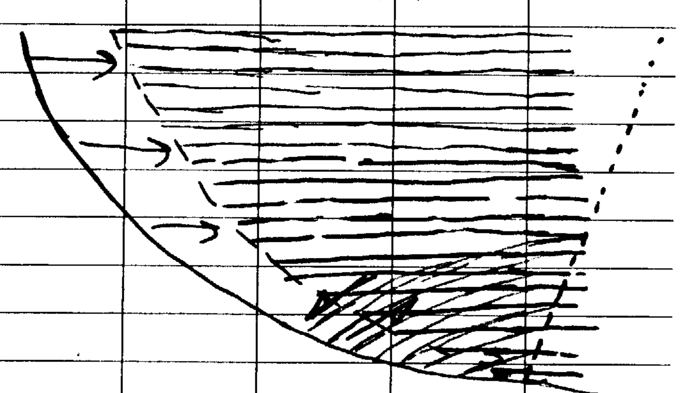
(A)



LAYER-PARALLEL SIMPLE SHEAR ~~ASSUMED~~ ACCOMMODATES FAULT BLOCK THINNING. WILL TEND TO REDUCE DIP.

(B)



• ROTATION ACCOMPANIED BY LIMB DOWN DIP SIMPLE SHEAR IN ROTATION, ~~AND~~ ACCOMPANIED BY LIMB EXTENSION AND LIMB THINNING.

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NOTE:

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

→ MODEL:

BARE MTN. NORMAL FAULTS ORIGINALLY DIPPED ~ SOUTHEASTWARD AND SLIP WAS GENERALLY DIP SLIP ON LISTRIC NORMAL FAULT SYSTEM. ROTATING BED DIPS MORE TO NW. LATER (OR SYNCHRONOUS?) UPLIFTING OF WEST SIDE OF MOUNTAIN W.R.T. EAST SIDE CAUSED ~~ROTATION~~ EASTWARD TILTING OF INTERNAL STRUCTURES ETC... RESULTING BEDDING DIPS ROTATED FROM ORIGINAL NW DIP, TO DIPS TO THE NORTH. EARLY FORMED SIMPLE SHEAR DEFORMATION FABRICS (FOLD AXES, CLEAVAGE/BEDDING INTERSECTIONS ETC...) WERE ALSO ROTATED, AND LINEAR ELEMENTS DEVELOPED PLUNGE TO ~~NNE~~. ORIGINAL DEPTH OF EXTENSIONAL DEF. ALLOWED RELATIVELY DUCTILE DEFORMATION.

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MODEL (cont.)

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

NOTE: ALAN LEAVES LEFT AFTER LUNCH TODAY.

12 Oct. '94 141.

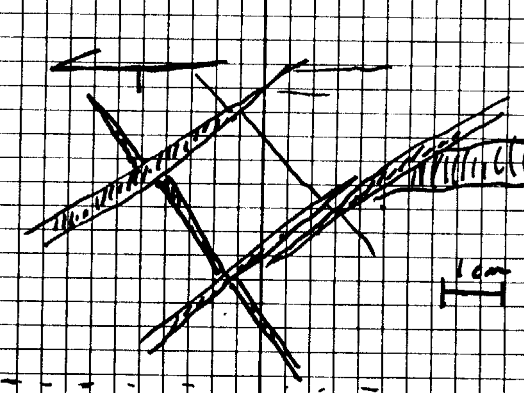
DAY 6 OF TECTONICS FIELDWORK

@ BARE MTN. NEVADA

DFSM28 – MD ELEANA

~~COMBINED~~ GRAINED LIMESTONE SAMPLE FOR MICROSTRUCTURAL ANALYSIS

065/62 N – ORIENTATION MARKED ON BEDDING.



WELL DEVELOPED FIBROUS VEINS (CALCITE?) IN AT LEAST TWO SETS. ~~FIBERS~~ FIBERS APPEAR TO PARALLEL DIP, REGARDLESS OF VEIN ORIENTATION! HIGH STRAIN SUGGESTED? OR SIMPLE OPENING IN BOTH VEIN SETS.

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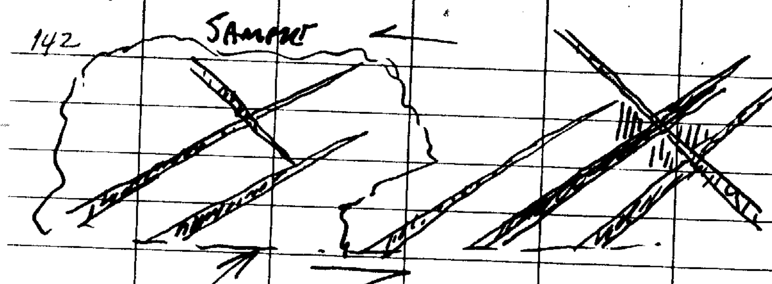


~~Shear~~ Shear zone @ base of sample.

⅄ 062/63N Bedding – Trace of smooth lithologic contact.

• Sample collected ~ 25 m from nearest dike in either side, east and west.

• Very strong fabric locally developed near veins that suggests either v. narrow faults in high amplitude stylolites, or grain scale extension, probably in wall quartzites.

→ Drove through Titus Canyon to Death Valley. Fractured – pebble conglomerate (Tert.). Evidence of downdip shear in ~~limestone~~

13 Oct. 94 145

Day 7 of Tectonics Field Work @ Bare Mtn.

= K. Saulnier 13.2/13.3. 2 w/c

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

Coarse grained / mixed sample for microstructural analyses. Sample oriented in bedding.

⅄ 071/45N Bedding.

123/62N extension lineations common in outcrop.

Sample collected 2 m west of dacite dike (altered?)

DFBM30 – Eleana Fm on Bare Mtn side. Black coarse grained limestone.

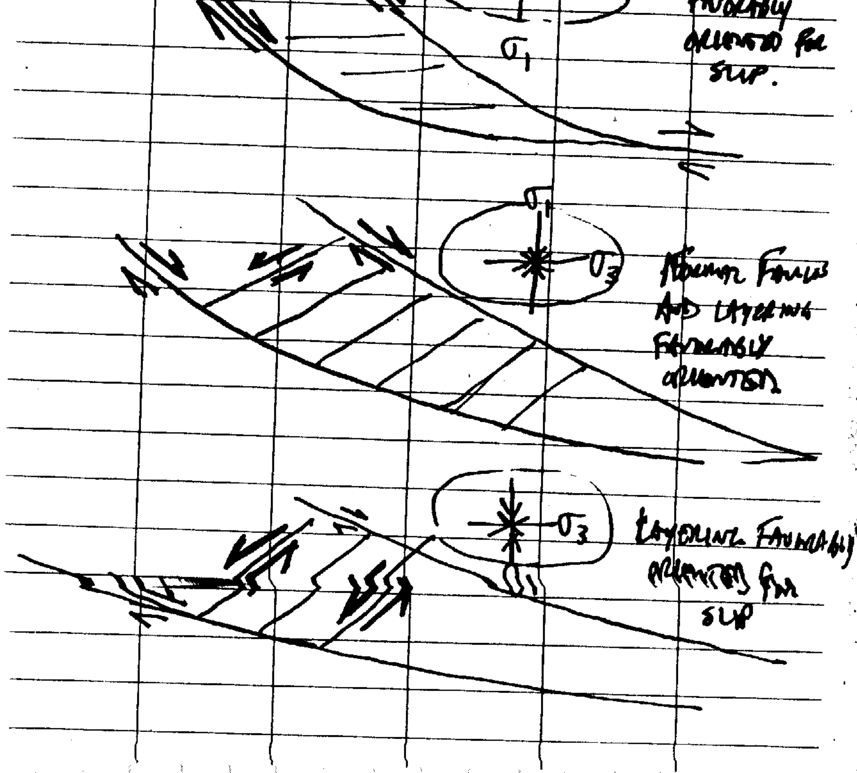
⅄ 157/60N – Mullion on bedding.

Sample for microstructural analysis.

144 29 October 1994 (Wednesday)

Flew San Antonio – Las Vegas. Drove to Beatty, NV, to participate in NRC/CNWRA GPS campaign. Back in Beatty, Nevada.

Thoughts from drive last night from Las Vegas to Beatty.



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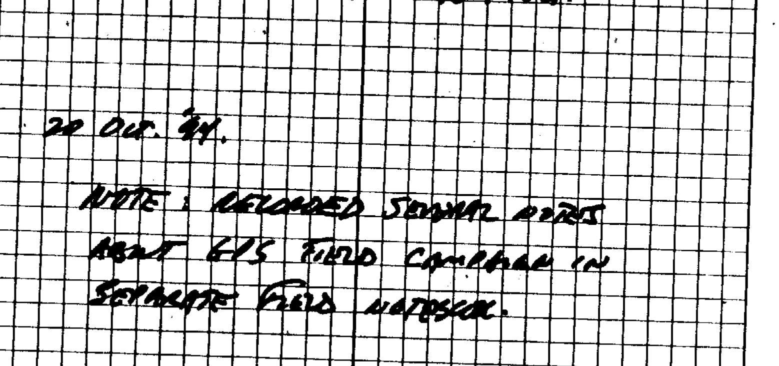
Idea for 45° plunge of Bare Mtn (northeastward)



• Rollover in hangingwall of listric normal fault.

30 Oct. 94.

Note: recorded several notes about GPS field campaign in separate field notebook.

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BEATTY, NEVADA. GPS SURVEY CONTINUES. RECORDED w/ GEORGE BIRCHARD @ STATION WAHMIE, EAST OF YUCCA MTN. @ NEVADA TEST SITE.

IDEAS FOR ANTITHETIC LAYER-PARALLEL SHEAR MODELS:

- ANTITHETIC SHEAR TO LISTRIC FAULT.
- RESPONSE TO FAULT-PARALLEL SIMPLE SHEAR - TRANS FAULT [illegible].
- RESPONSE TO "GLOBAL" PURE SHEAR. IN COMBINATION 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 φ THROUGH STRATIGRAPHY. (e.g. 30° ANGLE BETWEEN STYLOLITE TEETH AND

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BEDDING SEEN IN CARBONATE AT NEXT CANYON N. OF CARRARA CANYON

→ TO STUDY ANTITHETIC LAYER PARALLEL SHEAR, SHOULD PICK EXAMPLES AND MEASURE SECTION THROUGH STRATIGRAPHY AND RECORD DEFORMATION MECHANISMS AND AMOUNT OF SHEAR THROUGH [illegible]. WILL NEED φ VALUES TO TEST MODELS. (e.g. ① CARRARA CANYON OR ② NEXT CANYON NORTH OF CARRARA CANYON. FOR LARGE EXAMPLES (THICK STRAT SEQUENCE). ③ SMALLER EXAMPLES AT CANYON N OF CARRARA CANYON WHERE CARBONATE RX ARE CUT BY LISTRIC FAULT).

148 22 OCTOBER 1994

LEFT BEATTY, NV, AT 615 AM w/ PEDRO EL TO DRIVE TO TIN PASS TO OCCUPY "TIN PASS" GPS STATION.

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

DRIVING AROUND SOUTH OF TIN PASS. AT LOST BURRO ~~PASS~~ GAP.

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

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- TOOK NUMEROUS PHOTO'S HERE.

⇨ DROVE HIDDEN VALLEY, HUNTER MTN., PASS B/W PANAMINT & SALINE VALLEY, LIPPINCOTT MINE RD. (BEWARE!!!) RACETRACK VALLEY → PICKED UP PEDRO AT 6. HEADQUARTERS.

EVENING - TALKED w/ [illegible] SNOW TO [illegible] ABOUT GATE MTN. AND REGIONAL CONTEXT.

→ HE WAS NOT ORDINARILY CRAZY ABOUT MY SUGGESTION OF 45° TILTING OF BM, BUT ON OTHER HAND THINKS THIS MAKES MOST OF SENSE, AND EXPLAINS HIGHER MET. ON NW SIDE OF MTN. HIS HESITATION IS DUE TO LACK OF PLUNGE OF COMPRESSIONAL FOLD ASSOC. w/ PANAMINT THRUST. (I SUGGESTED POSSIBLE TWISTING.)

→ ALSO, HE LIKES SOMETHING ABOUT THE CONVERGENCE OF FOLD w/ RAMP AS PART OF REGIONAL CORRELATION w/ [illegible].

→ • GATE MTN. - BASINAL FACIES
• STRIPED HILLS - CARBON-PLATFORM FACIES.

150 22 Oct. 94

Zeke
→ Suggests mapping grapevines to north of Milton Reynolds' PLD area (Reynolds 1969. PLD Transit Building).

→ Zeke has done the paleomag. work @ John Geissman's lab.
. 4 sites plus Black Mtn.
& site at Qtz Latite dike in Tarantula Canyon. Drilled w/i 2" of Schweickert's sampled holes, plus several additional cores. Found no statistically significant signal at all. Questions Schweickert's student's data!
• Paleomag clearly gives strong [illegible]. Zeke thinks that magnetization in Cottonwoods unit JR and maybe same as S.M. [illegible] the [illegible] w/ cross-cutting relationships and same mag. orientations in host rock and JR intrusion (I think that this is what he said).

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Aside: [Karl Fox (UNR) suggests looking up w/ Brendan Dixon (sp?) at GSA. He's also w/ UNR.]

• Zeke says that some geologists [illegible] for [illegible] event is [illegible] that [illegible]. Caused by intrusion of Sierra Nevada batholith (Farley & [illegible](?))

• Zeke thinks that [illegible] sites could be [illegible] w/ [illegible] [illegible] (2) papers.

152 23 Oct. 94 (Sunday)

→ ~~Set~~ Set up "Black" GPS station w/ Gerry Stirewalt.

• Station is at SW edge of basalt flow ESW of Black Cone in Crater Flat Valley.

• Started recording at 10:16 a.m. Scheduled to continue recording until 6 PM.

• Drove back to Burro Inn via Tarantula Canyon. No time to collect additional OE (fission track) and OAV (nucleus/nuclide) samples.

• Checked out of Burro Inn and drove to Las Vegas. Made air flight to Seattle for GSA meeting.

23 Oct. 94 153

• Need to contact [illegible] Fed Center to assure funding of GPS project.
• Project is funded for 1 more year.
• Wernicke says would like/need 3(?) additional yrs measurement to reduce error/uncertainty for sites may [illegible] accuracy (precision?).
→ would like/need n = 6 or 7.
• Funding needs are ~$50K/yr.
→ Talk to Larry/Budhi/[illegible] about setting up contract to assure funding at project.
→ would be good to get [illegible] in [illegible] budget for NRC to cover this 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

2

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. Ajaurkbarry 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 of plot for Wakeman-Mike.
- May be some significant displacement among Lee Flat, Flats, Jackass, & Hunter Mtn. stations.
- Discussion of Oldows (Rice / UTD, Harlow) 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 Feaux	UWMC
George Bierkard	NRL
Gary Shimmel	CWRA
David Perry	CWRA
Pedro Elosegui	SAO
~~Tom~~ O. Reed	UWMC
Zeke Shaw	CALTECH

→ SIGNED UP IN OVERLOG.

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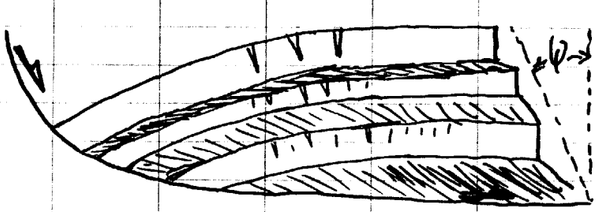
23 Oct. 1994.

EN ROUTE FROM LAS VEGAS TO SPRINGFIELD 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's EAST OF YM).
  – DEFORMATION MECHANISMS ASSOCIATED WITH EXTENSIONAL DEFORMATION.
  – ADDITIONAL SAMPLES FOR FAULT ZONE DEFORMATION STUDIES.
- DEATH VALLEY (ARCH) – FAULT & DIKE INTERACTIONS @ ~~BADWATER~~ TURTLEBACK
  – FAULT & DIKE INTERACTION IN S. DEATH VALLEY
  – GEOMORPHOLOGIC INDICATORS OF ACTIVITY OF DVFCFZ.
  – FAULT ZONE DEF. MECHS ON TURTLEBACK SURFACES.

B

23 Oct. '94.

- Rsh Lake Valley tuff/basalts (w/ John Oldow).
- Reconnaissance field work in Grapevine Mtns. To constrain cross sections & regional context of B.M.

Landers – Additional field recon. along surface ruptures?

Owens Valley – Fault & dike interaction at Big Pine, Coso.

Saline Range – Fault & dike interaction.

Mesa Butte – Additional data to constrain model of fault geometry.
– Make fracture data.

Reveille Range – Fault & dike interaction

Crater Flat – Many dikes. Map them.

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23 Oct. '94

1995 NRC/Caltech GPS Campaign

→ Activity this will be FY 96.

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19 Feb. 1995

Bare Mtn., Nevada

→ Week of field work: 19–24 Feb. '95
→ Staying at Furnace 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 Stonewall Hills.
- Study outcrop-scale normal faults in carbonates on west side of Bare Mtn. (sample).
- Sample Ordovician Antelope Valley Formation in fault blocks and footwall to normal faults west crest of Bare Mtn.
→ Also, sample veins if possible for Oxygen-isotope and fluid-inclusion studies.

19 Feb. 95

- Consider measuring section through normal-fault block to log deformation microstructures and in particular evidence of down dip stretching. 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 subsurface cross section across Grapevines and to Amargosa 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 zones.

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~~ DAE
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 Hauks → 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 - ~~Stirling~~ Zabriskie Quartzite ~~(?)~~ (Ɛz)

Six quartzite samples collected for fission track analyses.
Numbered
DFBM36.1 → DFBM36.6.

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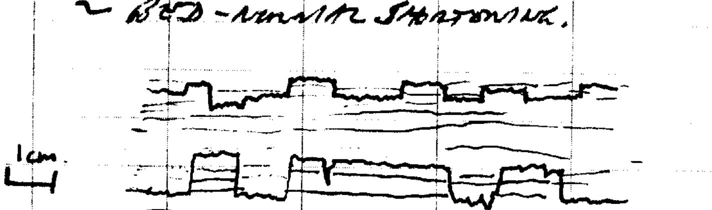
21 Feb. '95

BARE MTN. NEVADA -

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

DFBM37 - Photographs of ~~?~~ bed-⊥ stylolites in carbonates. No evidence of layer-// shear of stylolites. (Ɛbb1)

- 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.

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21 Feb. '95

DFBM38 - ^normal Fault ~~contact~~

Og on top of Ɛbb1.

- 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

⅄ 045/62 NW bedding. (May not be representative of general H.W. orient.)

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

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

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/bajada on W. side same mtn. and east draining dissected fans on E side of Grapevines.
- Photo's of Panamints in distance.

DFBM42 - Bedding-parallel veins in Hanging wall. Appears that fluid injected parallel to bedding flamsgating 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 Nixonole (Oc) Fm. Pelite verges down dip @ low angle to bedding
⊥ 065/41N bedding
⊥ 090/23 N cleavage

- Suggests down-dip shear.

DFBM44 - Cleavage in Ordovician Nixonole Formation (Oc)
⊥ 111/31N cleavage
⊥ 087/45N bedding

[signature]

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. Measured & 091/28N (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.

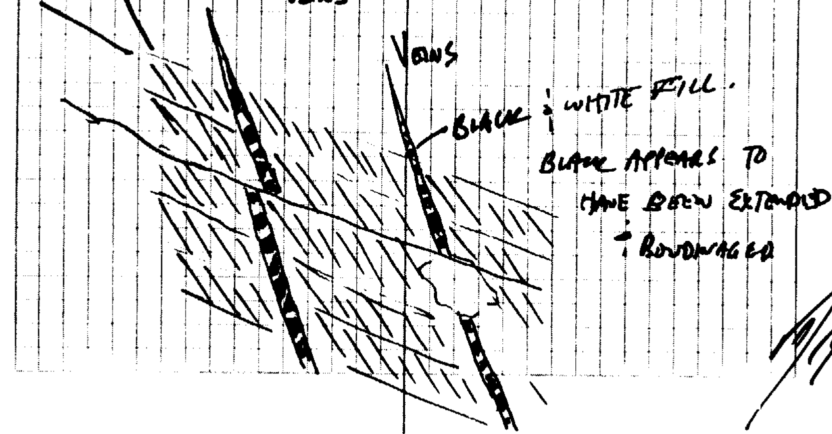
DFBM47 - Ordovician Antelope Valley fossiliferous bed sampled for microstructural analysis.

DFBM47.1
⊥ 073/34N 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)

S0 ⊥ 085/35N
S1 ⊥ 090/47N
Veins ⊥ 103/73N



[signature]

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

NOTE: THIS CLEAVAGE & BOUDINAGE OF VEINS IS EVIDENCE OF VEINS 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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DFBM51 - ORDOVICIAN EUREKA QUARTZITE.
5 SAMPLES COLLECTED FOR MICROSTRUCTURAL ANALYSIS.
DFBM 51.1 - DFBM51.5

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BARE MTN, NEVADA

- ANOTHER BEAUTIFUL DAY!

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

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

⊥ 099/20N BEDDING.

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

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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 - Y 069/53N MARKED ON BEDDING

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

Y 075/55N BEDDING

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

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

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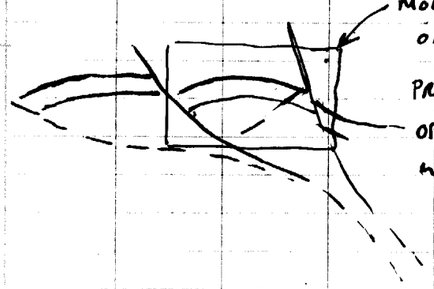


(PRELIMINARY NOTES FROM PRIOR TO ABOVE SKETCH)

FAULT ZONE EXPOSED AS SLIGHT BENCH IN CLIFF.

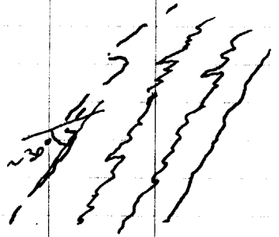
FAULT ZONE ~½ - 1 m THICK

DISPLACEMENT ~ [illegible]. 15m? (OR MAY BE FROM ↑ MAPLE FAULT)

ORIENTATION OF FAULT ⊦ 015/85E.

SHEARED STYLOLITES COMMON IN HANGINGWALL

BEDDING (HANGINGWALL)
Y 050/80N



↑ PHOTOGRAPH TAKEN OF THIS

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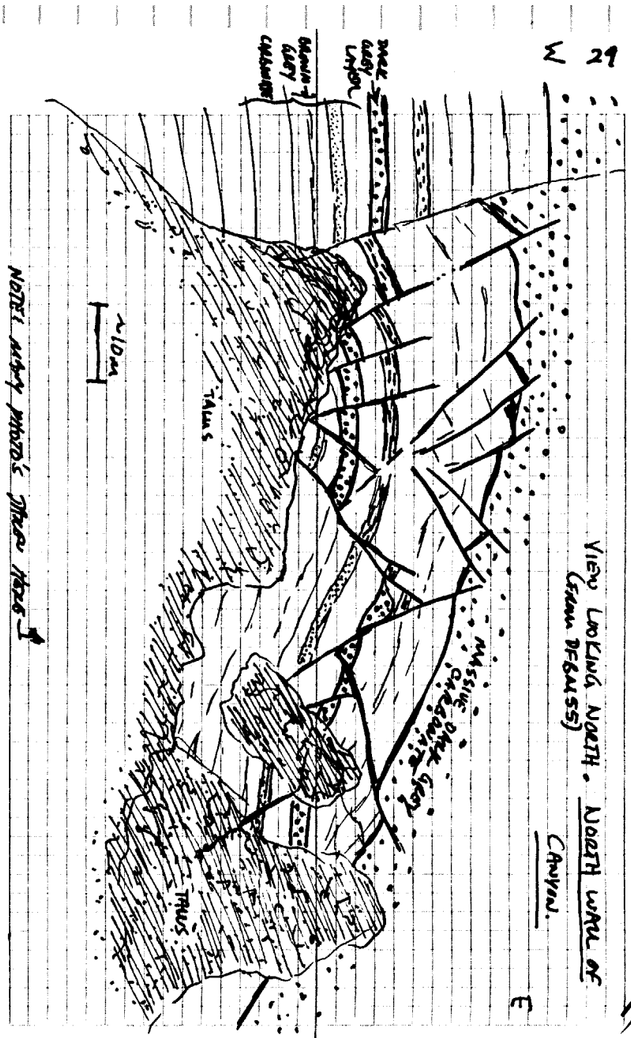

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ORIENTATIONS OF BEDDING AND FAULTS MEASURED AT LOCATIONS MARKED ON DRAWING ON FACING PAGE. MANY PHOTOS TAKEN OF THIS OUTCROP.

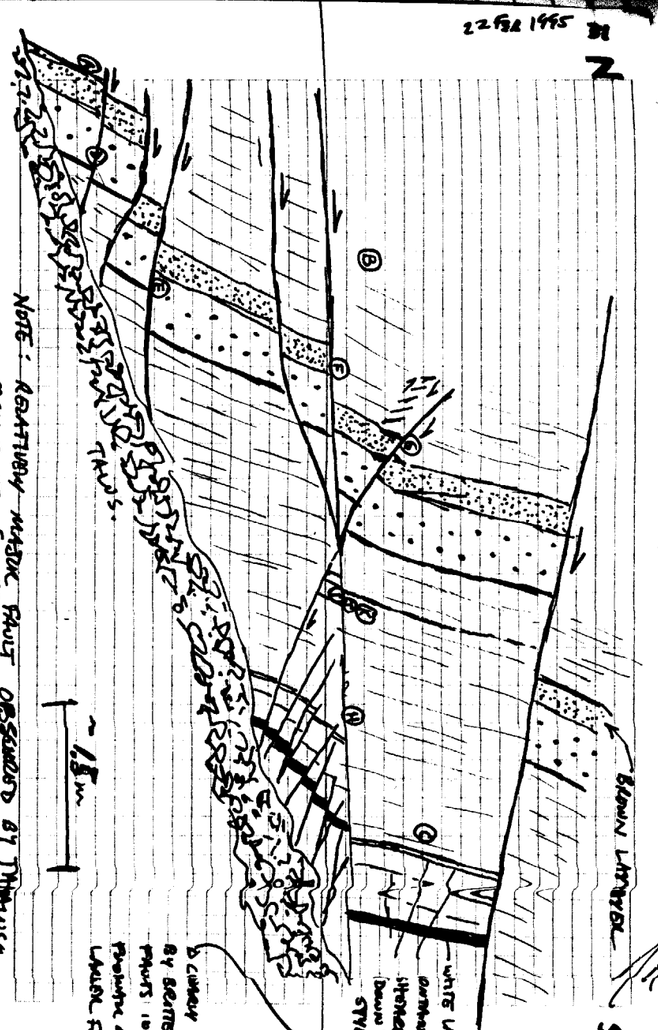
BEDDING
- (A) Y 067/78N
- (B) Y 062/62N
- (C) Y 063/70N

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 SOLUTION FABRIC THAT SUGGESTS DOWN-DIP SHEAR.

22 FEB 1995



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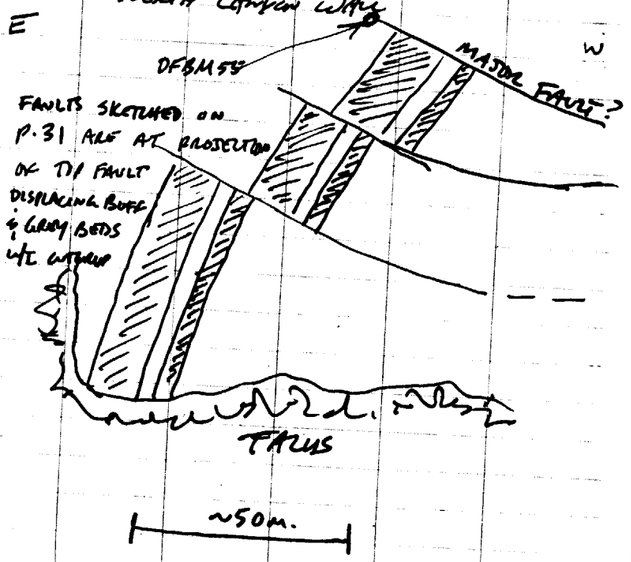
DFBM56 - Photo of normal faults cutting dolomite and limestone layers.

THIS PAGE ES SKETCH ON FACING PAGE IS VIEW LOOKING SOUTH AT SOUTH CANYON WALL FROM THIS LOCATION ON NORTH CANYON WALL



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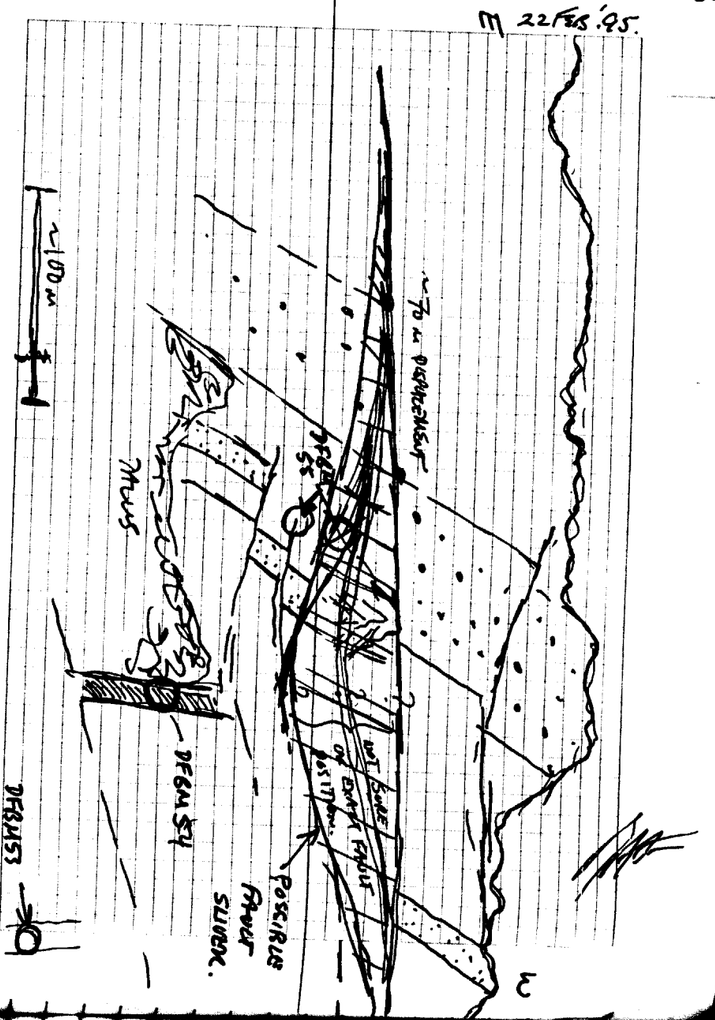

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DFBM57 - Zsdu - Sterling Quartzite sampled for fission track analysis.

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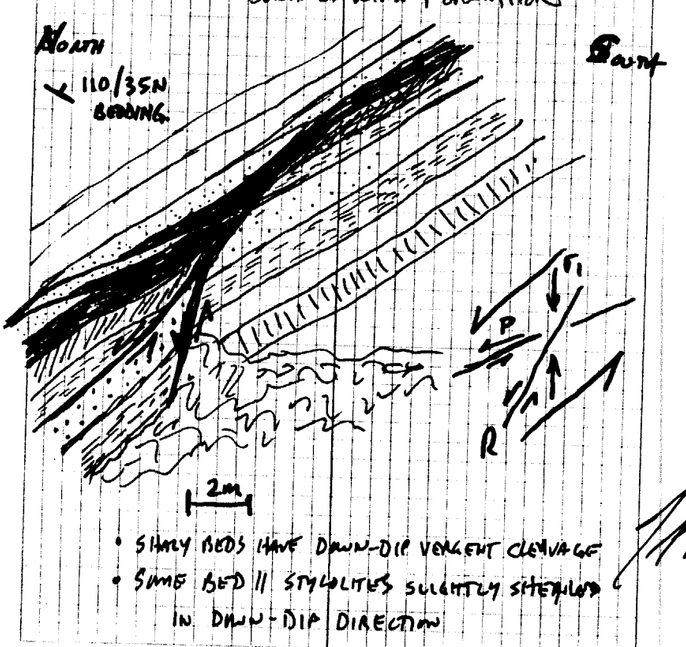
23 Feb 1995

Titus Canyon - Death Valley National Park

DFTC1 -

Cambrian Bonanza King Formation



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

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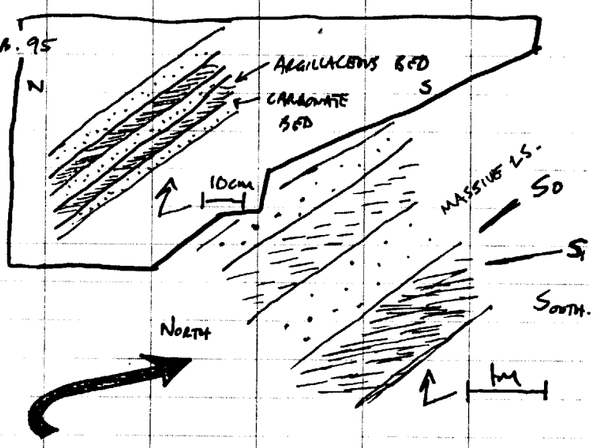
23 FEB. 95



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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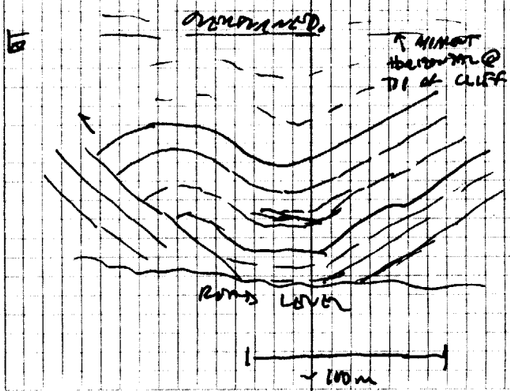
23 FEB. 95.

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 MARL LAYERS (~cm scale))

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



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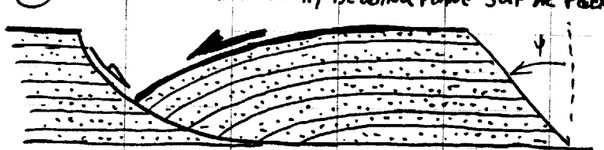
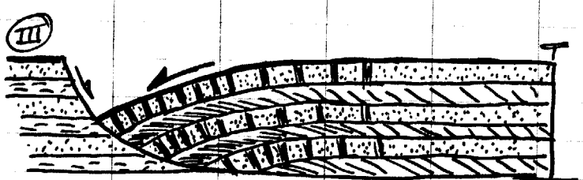
MODELS FOR DOWN-DIP SHEAR RELATED TO EXTENSIONAL FAULTING

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



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

(III)



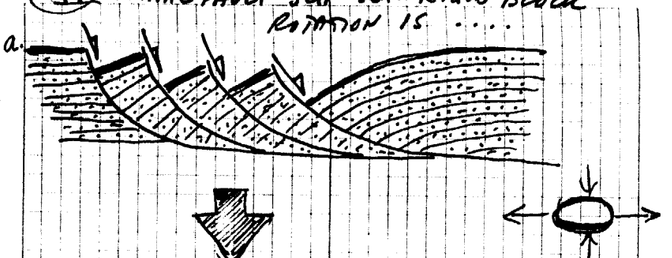
(NOTE: ALAN SUGGESTED THIS ON 21 FEB. 95 WHILE CLIMBING AND SAMPLING BARE MOUNTAIN).

39

23 FEB. '95

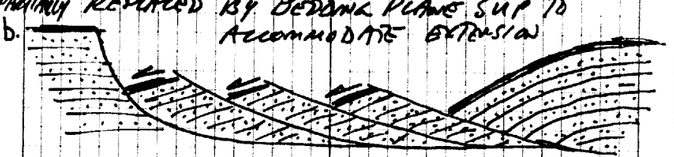
(IV) INITIAL FAULT SLIP WITH RIGID BLOCK ROTATION IS ....

a.



PARTIALLY REPLACED BY BEDDING PLANE SLIP TO ACCOMMODATE EXTENSION

b.



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

* SHEAR MAY INCREASE W/INCREASING RELATIVE DIP WITHIN A SINGLE STRUCTURE.

? SEE MODIFICATIONS ON NEXT P.

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

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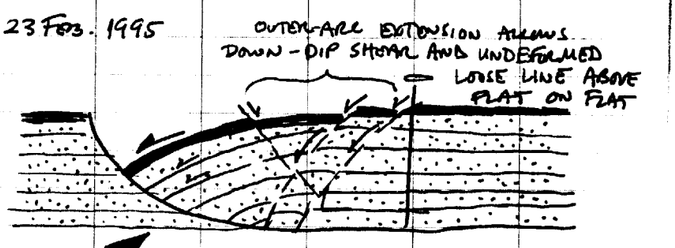
23 Feb. 1995



MODIFICATION OF MODELS (I) AND (II).

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2 MAY 1995

LAS VEGAS – DEATH VALLEY REGION
RECONNAISSANCE FIELD WORK.

FIELD PARTY: J. KENT "ZEKE" CAMPBELL SUMA,
JOHN STAMATAKOS, DAVID FERRILL.
↑
U. MICHIGAN

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

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

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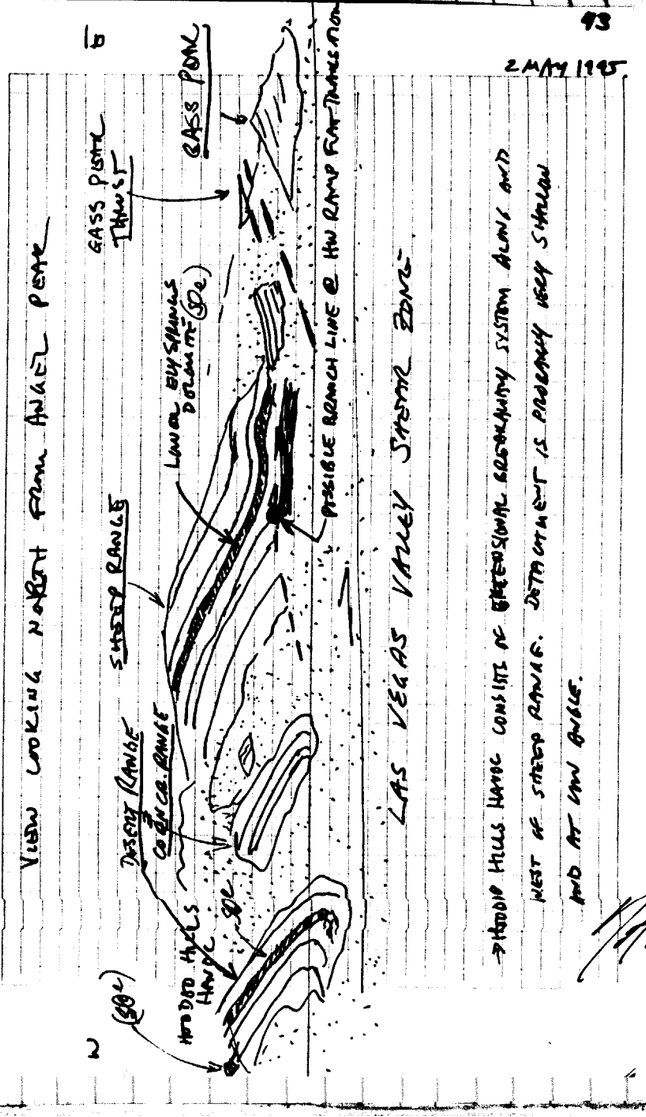
2 MAY 1995



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2 MAY 1995.

Across W Valley Shear Zone.

→ Offset thrust faults indicate 60 km Right Slip.

- Gass Peak Thrust correlated w/ Wheeler Pass Thrust (in Spring Mtns.).
  - Steep HW & FW ramp
  - 5-6 km strat. throw
  - First occurrence of Ediacaran rx in hangingwall
  - 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 at Bonanza King.
  - Complex footwall geometry involving Jr Aztec. ~~w/ + off~~
  - Tight & locally recumbent footwall synclines.

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2 MAY 1995.

Burchfiel, Hamill & Wilhelms. 1982.
GSA Map & Chart Series MC 44.
↳ → Montgomery Mtns. Map – Burchfiel mapped isopac relationship in middle Stirling Quartzite that suggests 10 km right slip. (would ~ close up Stewart Valley).

→ All stratigraphers say RL SS < 25 km.

→ Schweickert insists ≥ 25 km RL SS @ Stewart Valley –

* This could be quite important for Bare Mtn, Crater Flat, YM interpretation.

Also – Schweickert's hooks at Wood Canyon sandstone @ 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.

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2 May 1995

A.R. "Pete"

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

→ Tony Prave also lots about this Paleozoic stratigraphy.

* Mercury Klippe – stratigraphic test of structural models.

Kuehy & Schweickert vs Snow and Wernicke.

→ Oslager & Montenegro ⇒ @ UC Riverside. Cambrian (Bonanza King) Stratigraphers.

Dave Oslager → no stiff money & would be great to have measured sections.

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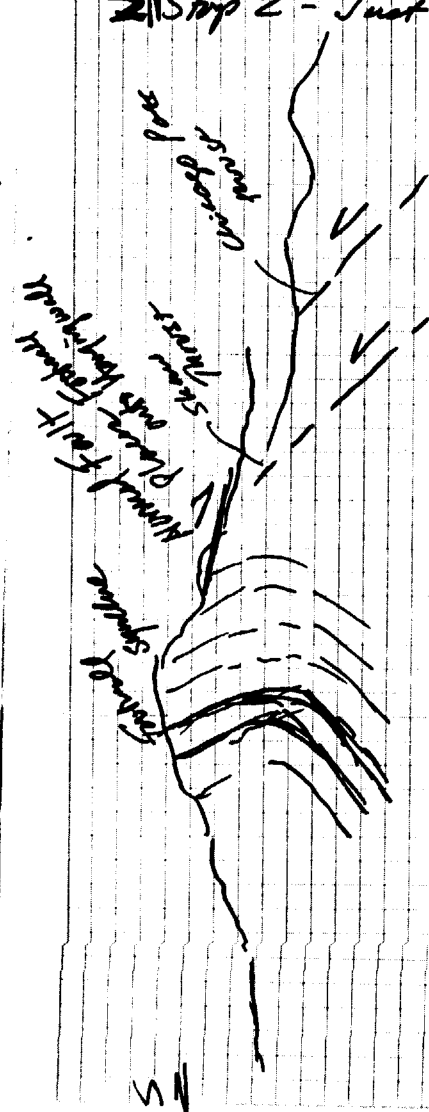
2 May 1995

North. Stop 2 – Just east of Chicago Pass



View looking west @ Nopah Range from immediately east of Chicago Pass.

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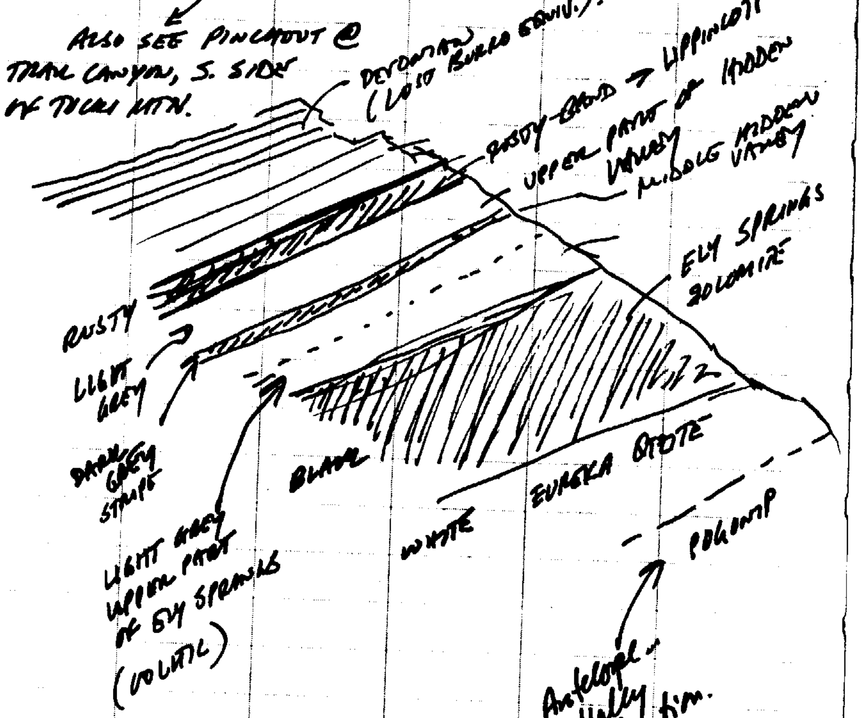
2 MAY 1995

STOP 3 – Chicago Pass.

Pinchout of Silurian Section to South is exposed here.



VIEW LOOKING SOUTH AT NOPAH RANGE FROM CHICAGO PASS.

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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 ARGUS PASS.

- UNPUBLISHED DATE (ARGON LASER FUSION) FROM OVERLYING TUFF @ 15 Ma. (MAYBE 15.7 ACCORDING TO ZEKE SNOW).
  - ZEKE SAYS MAY BE TUFF OF UNCONFORMITY HILL.
- BOULDERS IN CONGLOMERATIC BEDS VARY QUITE A BIT IN MAFIC MINERAL CONTENT.

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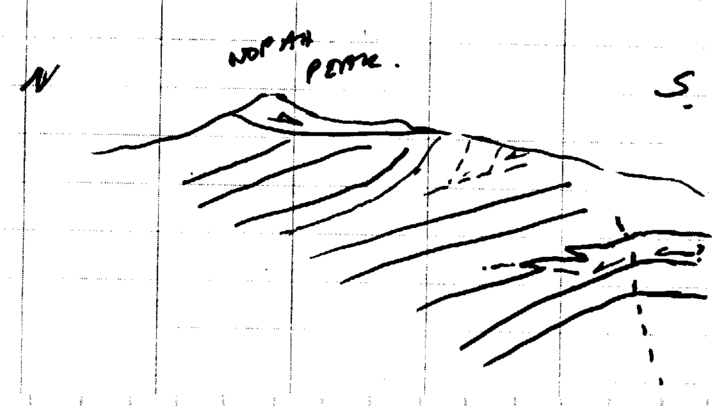
2 MAY 1995.

- INTERPRETED DEBRIS FLOWS. MATRIX-SUPPORTED BOULDER CONGLOMERATES.
- WE'LL CALL THIS STOP "ZEKE'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 METASEDS. ARE 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. SWAN.

STOP 1 - BOUNDARY CANYON DETACHMENT
HANGING WALL WEST OF DAYLIGHT PASS (BETWEEN BEATTY & FURNACE CR.). (UPPER SPLAY OF BOUNDARY CANYON DETACHMENT).

pC JOHNNIE FM. IN 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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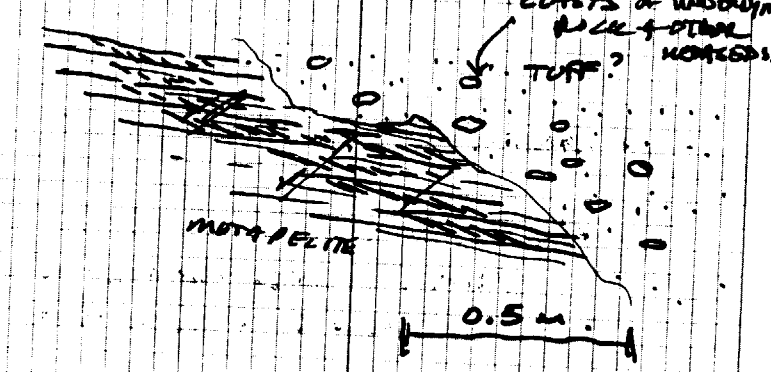
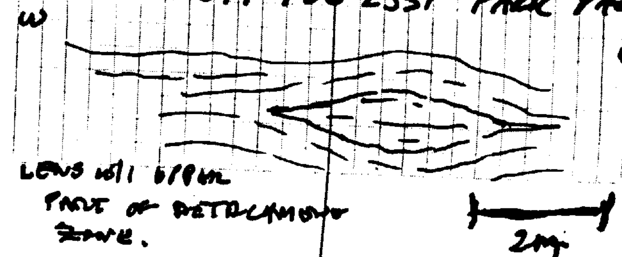
3 May '95.

LENTICULAR FABRIC W/ MARBLE + SLATE LENSES. CLEAVAGE @ V. LOW ANGLE TO LAYERING IN METAPELITE.



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

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



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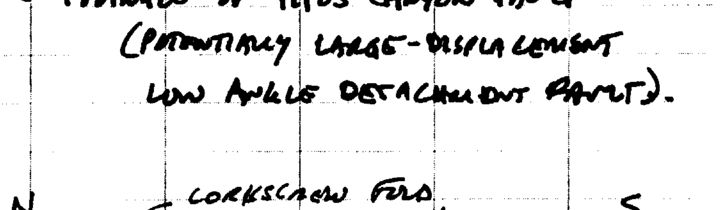
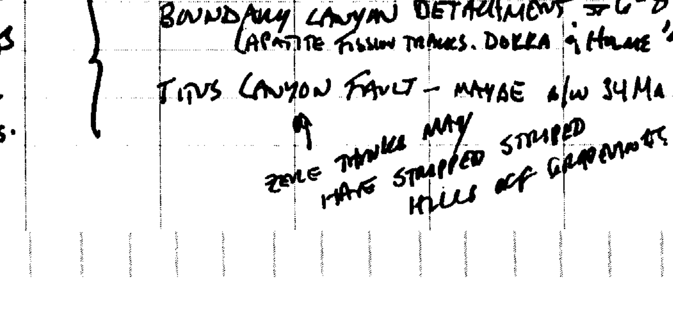
3 May '95

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



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



ZELL INTERPRETS THESE FAULT AGES.
{ BOUNDARY CANYON DETACHMENT ≈ 6-8 MA. (APATITE FISSION TRACKS. DOKKA & HOLMES '91?).
TITUS CANYON FAULT - MAYBE A/W 34 MA; 36 MA.
ZELL THINKS MAY HAVE STRIPPED STRIPPED HILLS OF GRAPEVINES

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3 May '95.

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

IGC 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 beds.

STOP 8 - Petroglyphs on outcrop of Mesquite Spring ~~Darwin ... Ridge~~ tuff (3.1-3.2 Ma) (≈3 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., Grapevine, Funerals, Blacks, Bare Mtn., Spring Mtns.

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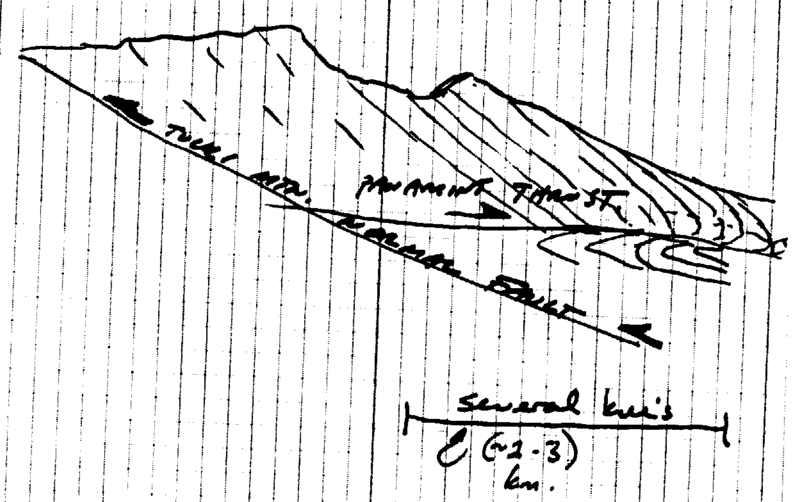
3 May '95

View looking N at east flank of Tucki Mtn.

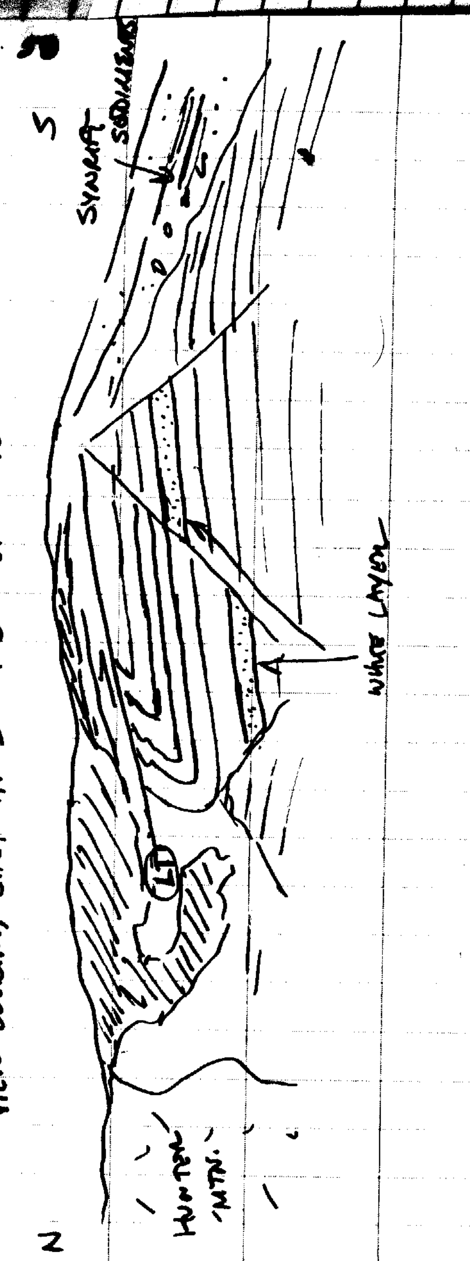


Wernicke et al 1989 IGC Field Trip Guide Stop # 6-3.

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

Wernicke et al 1989 Stop # 6-

58



View looking east at south end of Cottonwood Range.

3 May '95.

- LT = Lemoigne Thrust.

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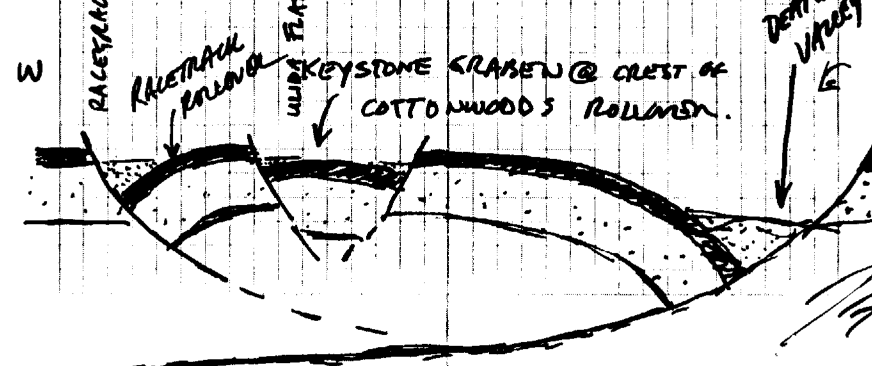
4 May 1995

Cottonwood Mtns. w/ Bill 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.
Lemoigne Klippe, (piece of Last Chance Allochthon), Cottonwood duplex zone, White Top backfold, Lost Burro Gap monocline, and en echelon graben structures.



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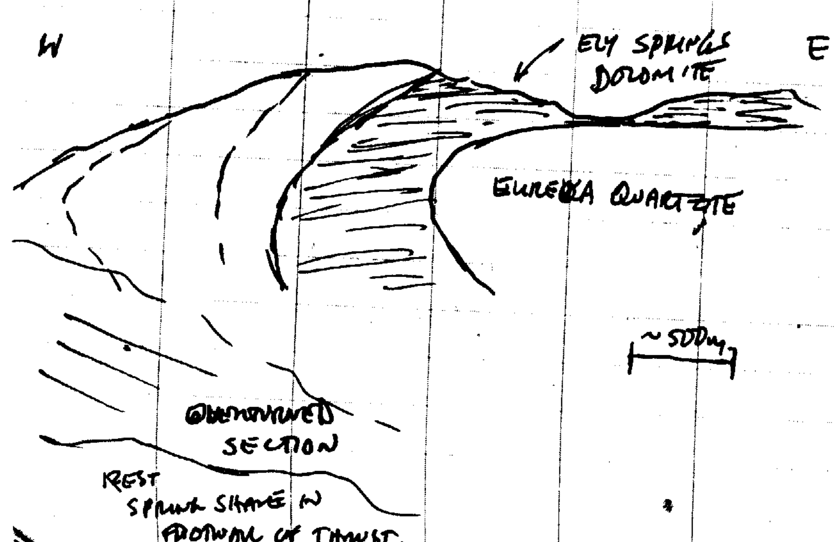
4 May 95

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 BACKFOLD.



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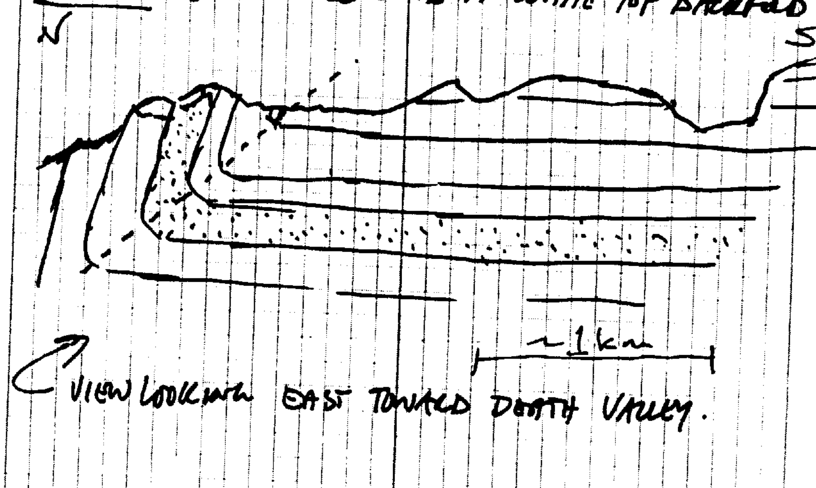
4 May '95.

WERNICKE et al. (1989) IGC FIELD GUIDE STOP

STOP 4 - OVERTURNED LIMB OF WHITE TOP BACKFOLD



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	Permo-Triassic Pluton Geology	Snow et al.
1992	GSA Bulletin - Large Mag Plate Post	Snow
1990	GSA Mem. -	Snow & White

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

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4 May 95.

STOP 5 - THRUST IN FORELIMB OF WHITE TOP BACKFOLD. 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 GAS CAMPAIGN. (FURTHER EAST IN CANYON).

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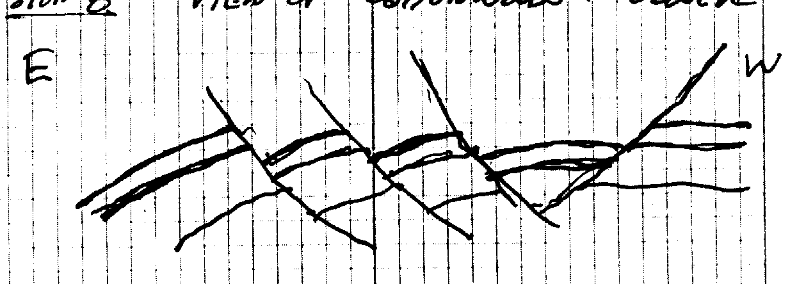
4 May '95.

* SHOULD COME BACK AND CHECK OUT FOR LAYER-PARALLEL SHEAR MODES.
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 RADAR APPROACH TO DATING LANDSLIDES - SUGGESTED BY JOHN STAMATAKOS.

STOP 8 - VIEW OF COTTONWOODS BACKFOLD



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4 MAY '95.

1992 GSA BULLETIN PAPER -
— SNOW

→ DISCUSSES DUPLEX ZONE IN FOOTWALL OF LAST CHANCE THRUST
→ DISCUSSES [illegible] PEAK THRUST/FAULT

1994 CASHMAN TREXLER & OTHERS
(GSA CORDILLERAN SECTION GUIDE.
→ SAY THAT CHAINMAN & ELEANA IN MINE MTN AREA ARE GRADATIONAL -

[DUPLEX INTERPRETATION
→ GO BACK TO USGS MAP.
W. YUCCA FLAT.
(ZENE HAS REFS.)
MINE MT. QUAD.
CP HILLS QUAD.

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4 May '95

ZENE 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 & HALLEY 1979 CARRARA.
U.S.G.S. PROFESSIONAL P. 1047

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5 MAY 1995

OVERFLIGHT OF DEATH VALLEY — OWENS VALLEY REGION

OVERFLIGHT IN CESNA 210 CHARTERED FROM ASSOCIATED JET CHARTER, LAS VEGAS, NEVADA.

ASSOCIATED JET CHARTER - JIM JAKUS
TEL: (702) 798-4600
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

OVERFLIGHT 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 FEATURES 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
Δ 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.
Δ FURNACE CREEK (LUNCH STOP).
GRAPEVINE RANGE
- CORKSCREW SYNCLINE
- "BALLFORD"
- TITUS CANYON DETACHMENT
BULLFROG MINE
BARE MTN.
- FAULTED TUFFS @ N. END.
- BARE MTN. FAULT (TRENCHES)

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5 May 95.

- PANAMINT THRUST & FURNACE 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.

70
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 TYNAN.

~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 WELDED UNITS TEND TO BE THIN.
- EVIDENCE OF STRIKE SLIP COMPONENT "LOW-ANGLE SLICKENSIDES".
- 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 PASSAGEWAYS.
- V. FEW FRACTURES W/ ~ CONTINUOUS FRACTURE FILLINGS.

→ WATER IN TUNNEL. (MAY BE NATURAL OR INTRODUCED)

- MOIST CLAY IN FRACTURE EAST OF BONNIDGE FAULT.
- MOISTURE @ ~ 512 ("HIGHLY DISTURBED")
  → SEASONALLY INTRODUCED

FIELD TRIP TO UE7a 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 UE7a DRILL PAD EXPOSURE. SCARP 1-2m HIGH AT THIS SPOT. EXCAVATED EXPOSURE OF HIGHLY FRACTURED ROCK ~ 20m.
- SEVERAL OTHER NORTH-SOUTH TRENDING FAULTS HAVE BEEN MAPPED IN THIS AREA.

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17 May 1995.

- PRESERVING COOLING JOINT FABRICS

NW, NE → TRENDING COOLING JOINT TRENDS.

→ DEFORMATION MAY HAVE CAUSED REORIENTATION OF COOLING JOINTS.

WARREN DAY – 4.5GS. DISCUSSED.

- 1:6000 MAPPING OF AREA.

ERNIE MARTEL

- DISCUSSED SHALLOW SEISMIC LINES ACROSS THE GHOST DANCE FAULT AT THIS LOCATION FROM DRILL PAD. (FOUR LINES)
  - HAMMER & PLANE SOURCE – SEE FAULT TO 2500'.
  - OTTAWA SEISMIC SHOT USING IMPACT SOURCE AND 12m SPACING.

PROFILES MORE CONTINUOUS ACROSS WATER TABLE.

- VELOCITY PULL DOWN MAY BE RELATED TO FRACTURING ASSOCIATED W/ GHOST DANCE FAULT.

SHADELUX. WILLIAMS-STROUD

DISCUSSION OF BULLETIN MAP OF STRUCTURES IN TUFF CONTAINING EXPOSED AT UE7a DRILL PAD.

MAPPING SUGGESTS 60-70' DISPLACEMENT

CRYSTAL RICH VS CRYSTAL RICH BOUNDARY IS OFFSET.

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17 MAY '95

DISPLACEMENT CHANGES ACROSS RIDGES TO NORTH 60-90' ↓ 90' 45' — N

SECONDARY FAULT HAS 2-3 m DISPLACEMENT.

HIKED UP WHALE BACK RIDGE FROM UE7a DRILL PAD.

RICK SPENGLER

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

EMILY TAYLOR

– TRENCH ACROSS 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 OFFSET BY FAULT.

75

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 GUEST – 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 (MAY USE TUFF STRATIGRAPHY & EROSION.

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

76
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

77
17 MAY 1995

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

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

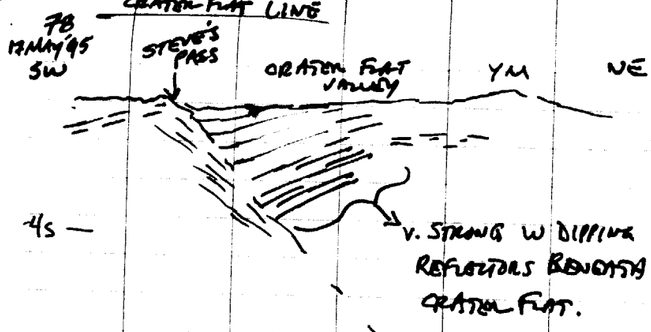
→ TESTED SOURCE AND RECEIVER ARRAYS.
* 4 VIBROSEIS TRUCKS.
* RECEIVATION SYSTEM.

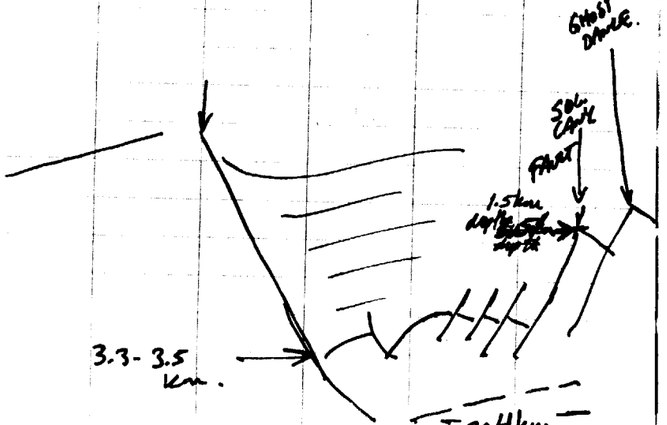
I/O SYSTEM II RECORDING SYSTEM
PERTON VIBRATION SENSORS
:

→ "STATE OF THE ART TECHNOLOGY"

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

78
17 MAY 95
SW





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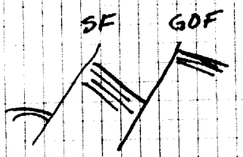
17 MAY 1995.

→ 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 LISTRIC NORMAL 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 -
RV4 - MAIN TRENCH
- SITE OF ONGOING SEISMIC ACTIVITY -
- INCLUDES LITTLE SKULL MTN. QUAKE IN PATTERN.
- 18+ km LENGTH OF LEFT LATERAL STRIKE SLIP FAULT.
CROOK VALLEY IS TERMINUS 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.

82
18 MAY '95

LAST YEAR, JIM BRUN REPORTED 3-4 <M2 EARTHQUAKES JUST NORTH OF HERE ON "MEDIAL STRAND" OF RAIL 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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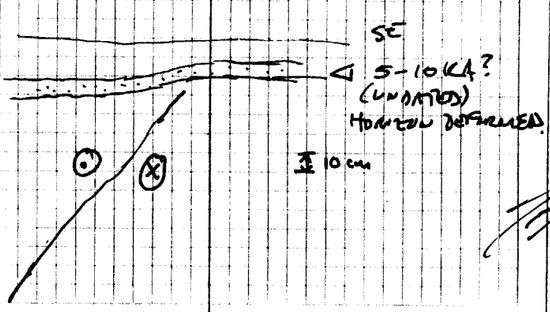
18 MAY '95.

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.

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

- UNIT 4 (SOIL HORIZON) SEEN HERE LOOK LIKE 40-100 KA SOIL MAPPED ACROSS THIS REGION. THIS SOIL HORIZON IS CLEARLY BROKEN IN THIS TRENCH.



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18 MAY 1995

RV4 - TEST PIT 2.
JIM YOUNT

→ CLEAR/ ~~FAULTING~~ THAT AND FRACTURES
{ CUT LAYERED ALLUVIUM, CALCRETE,
{ ETC...

→ YOUNTS GUT FEELING IS THAT THESE WELL CEMENTED UNITS 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 CORRELATIONS,

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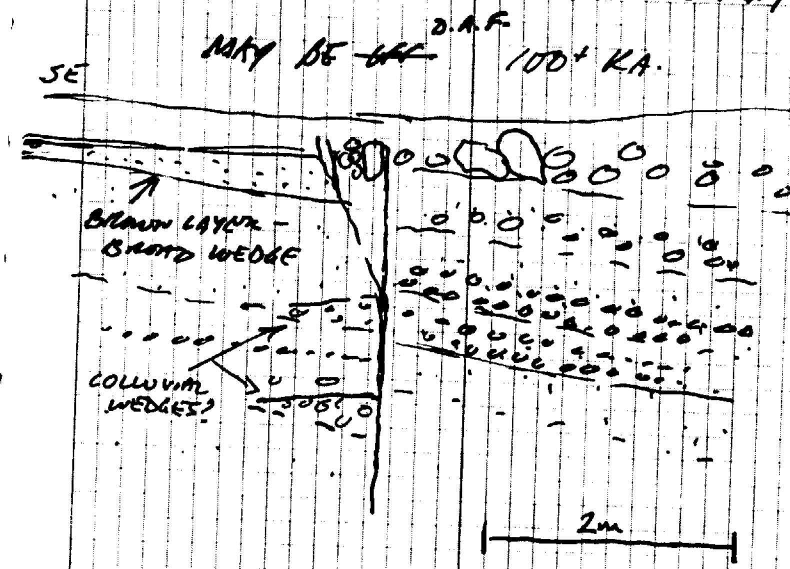
18 MAY 95.



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 OF TOPOPAH SPRINGS TUFF
- UPPER LITHOPHYSAL (NEAR TOP OF NON LITHOPHYSAL ZONE).

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

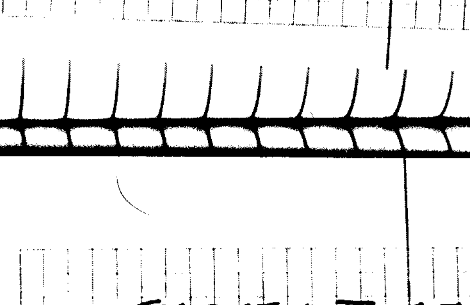
→ OBSERVATIONS APPARENTLY NOT TRANSPORTABLE TO TIVA CANYON.

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

87
18 MAY 95.

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

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



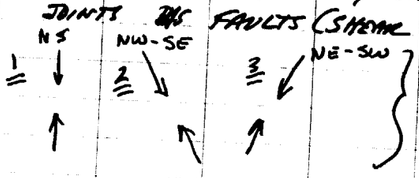
LATERAL DECREASE IN INTENSITY OF NW TREND. COOLING JOINTS. ROUGH, SHORT TECTONIC JOINTS (ALSO NW TRENDING) MORE ABUNDANT WHERE COOLING JOINTS ARE LESS ABUNDANT. MAY HAVE ACCOMMODATED

88

18 MAY 1995.

NE EXTENSION BY APERTURE INCREASE ON COOLING JOINTS WHERE FROZEN

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



KLAN 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?

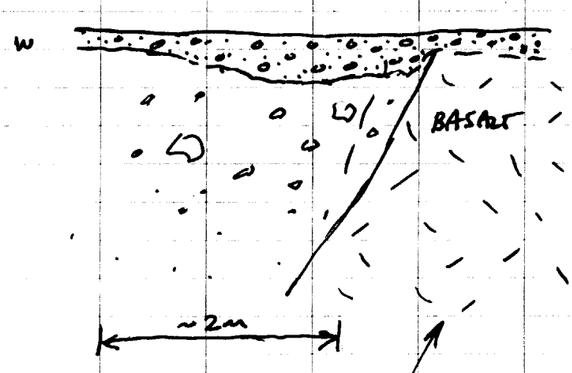
- MAPPING HAS NOT EXTENDED SUNDANCE TO YUCCA MTN. RIDGE CREST. NO EVIDENCE.
- MAPPING HAS IDENTIFIED SPLAYS OFF OF SOLITARIO CANYON FAULT. DIPPING STEEPLY TO WEST.

90

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. POST DATES 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

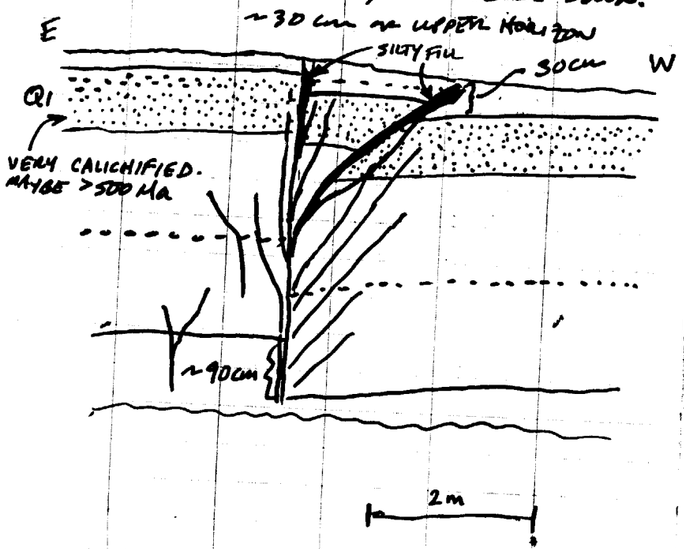
CRATER FLAT TRENCHES

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



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18 MAY 95

STAGECOACH ROAD FAULT HAS CA. 1 ORDER OF MAGNITUDE SMALLER RECURRENCE 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).

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

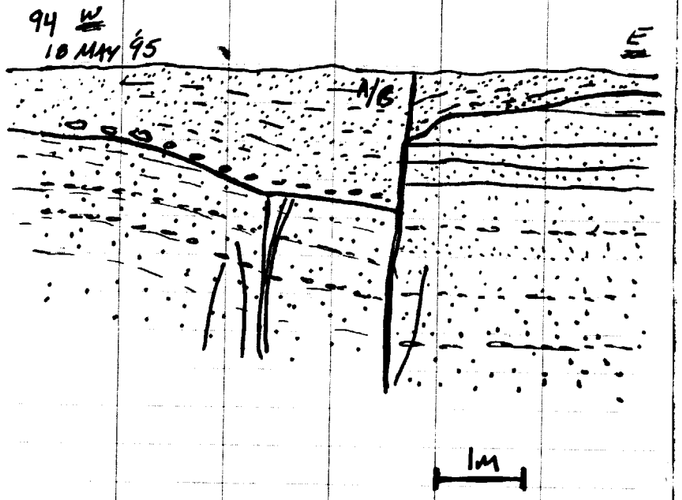
EMILY TAYLOR

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



95
22 AUGUST 1995

CALGARY, ALBERTA, CANADA

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

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

→ BEAUTIFUL WEATHER → CLEAR AND IN 70's.

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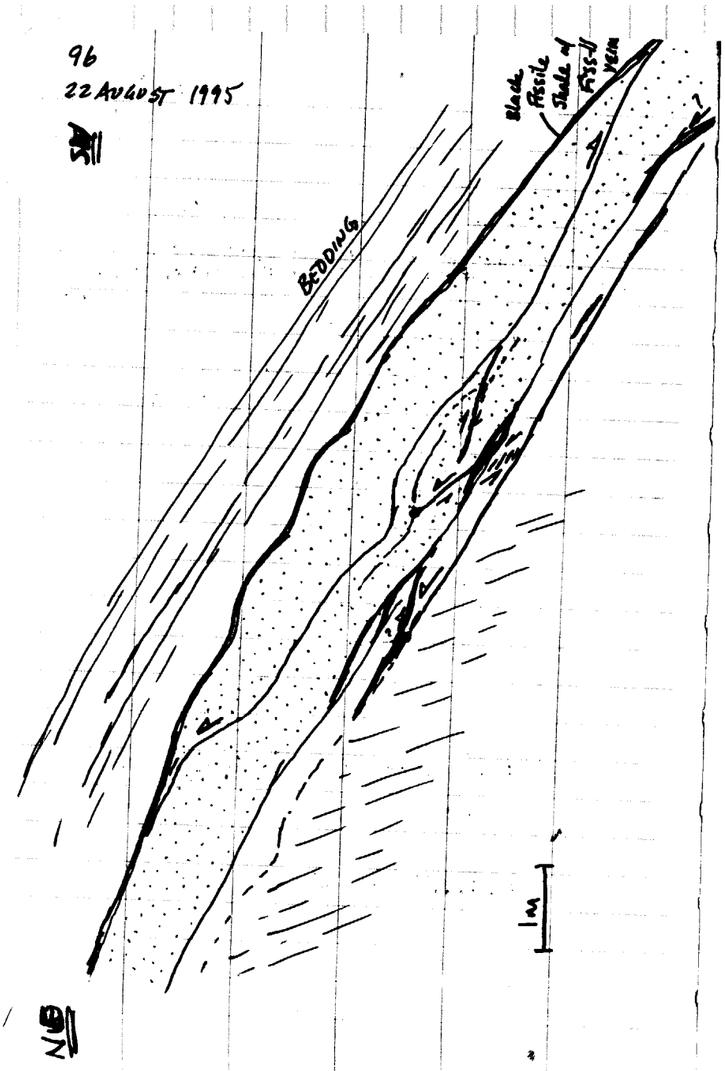
22 August 1995



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23 August 95

FIELD TRIP DAY 1

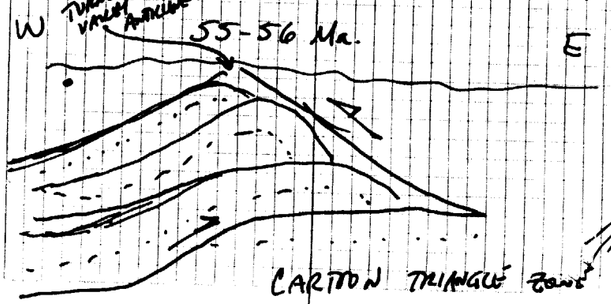
PENROSE CONFERENCE ON "FAULT-RELATED FOLDING"

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 - PAUL MACKAY . . . → TURNER VALLEY ANT.
- DATE OF THRUSTING, FROM APATITE FISSION TRACK THERMOCHRONOMETRY.



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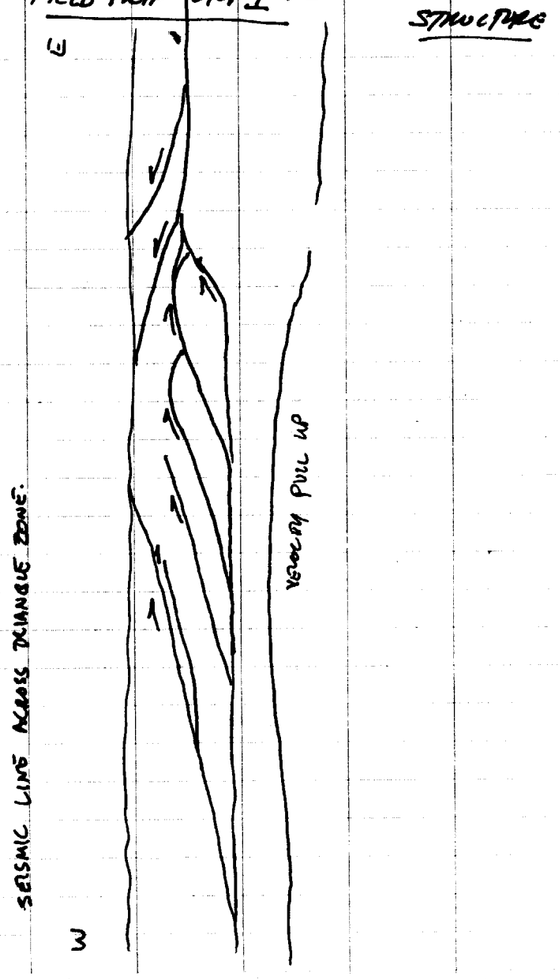
8/21/95

FIELD TRIP | STOP 1 - THE TURNER VALLEY STRUCTURE



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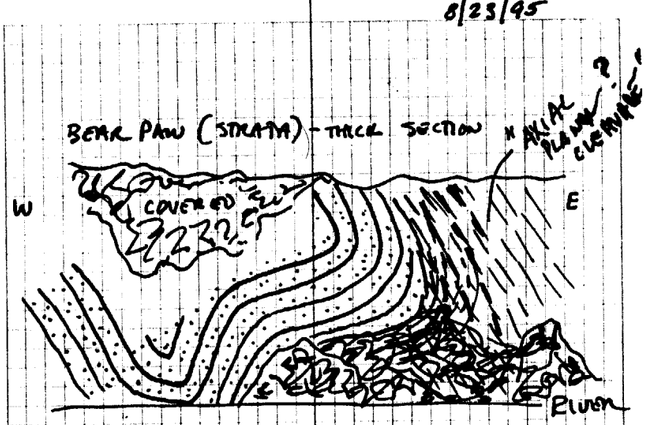
8/23/95



- ASYMMETRY - LONG LIMB & SHORT LIMB.
- 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.

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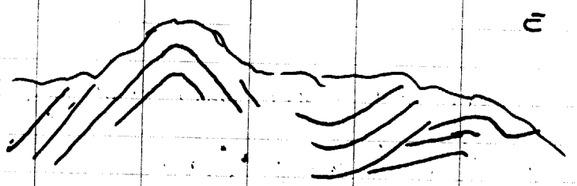
8/23/95

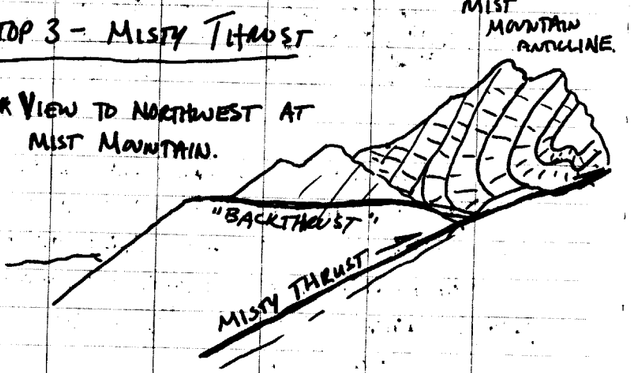
MOUNT HEAD

W E



STOP 3 - MISTY THRUST

* VIEW TO NORTHWEST AT MIST MOUNTAIN.



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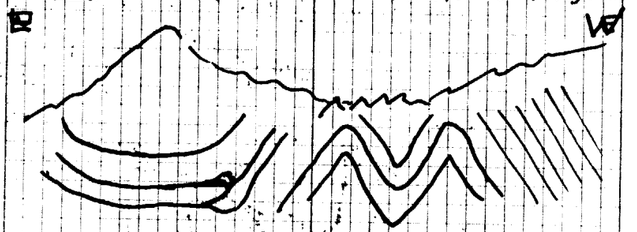
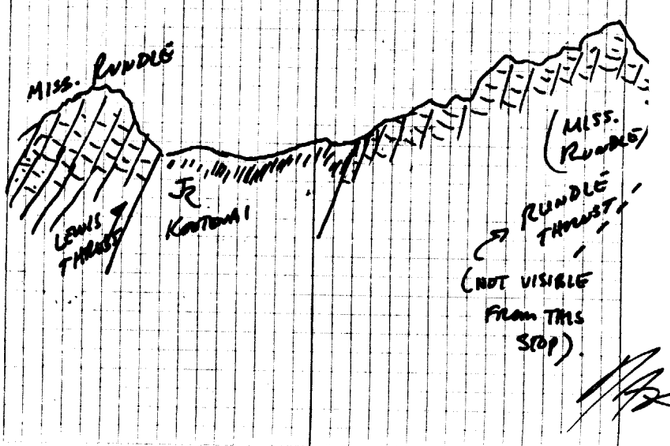
8/23/95.

STOP 4 - LEWIS THRUST AT HIGHWOOD PASS



W E



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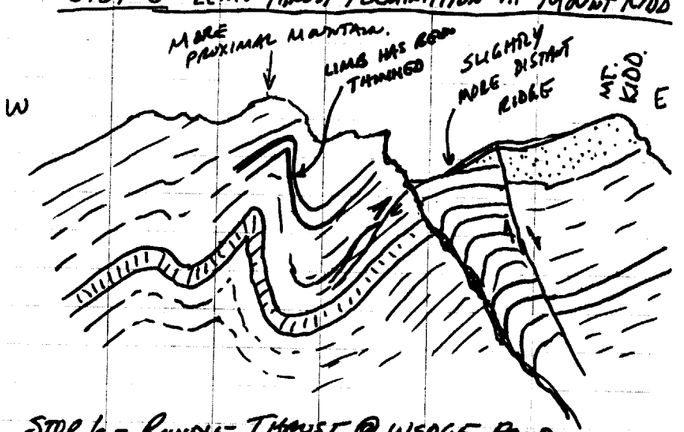
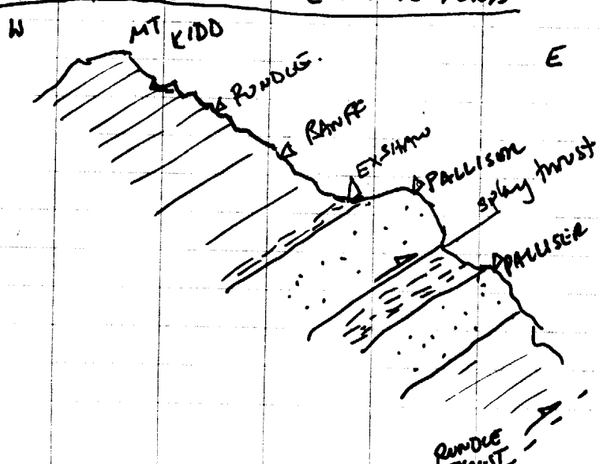
8/25/95

STOP 5 - LEWIS THRUST TERMINATION AT MOUNT KIDD



STOP 6 - RUNDLE THRUST @ WEDGIE POND



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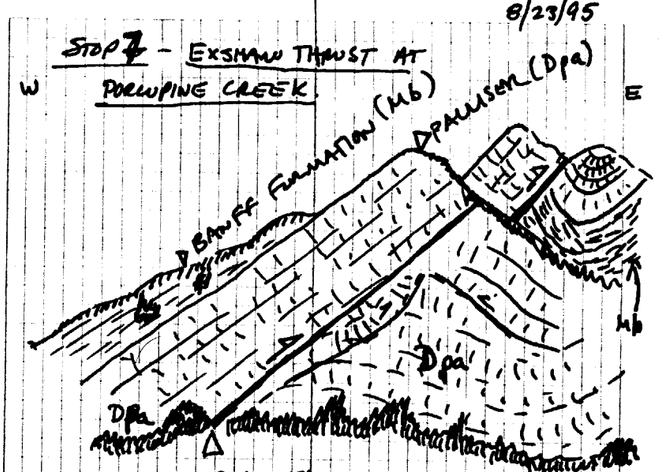
8/23/95

STOP 7 - EXSHAW THRUST AT PORCUPINE CREEK



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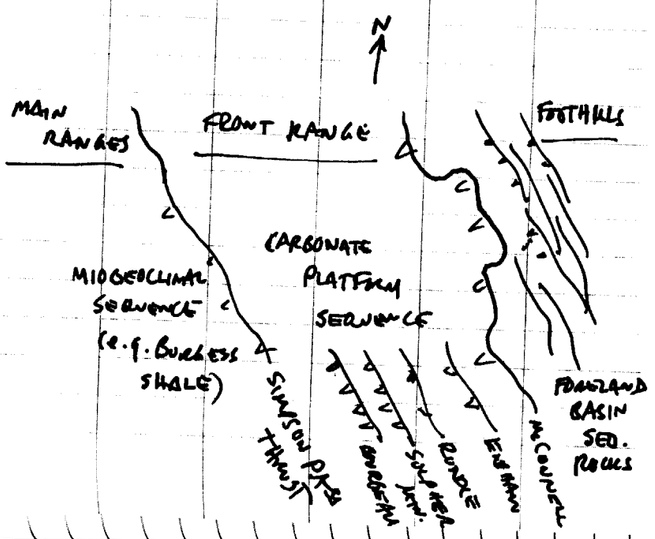
8/25/95

FIELD TRIP DAY 2

- LEADERS: RAY PRICE & BOBBIE SPRATT
- BANFF 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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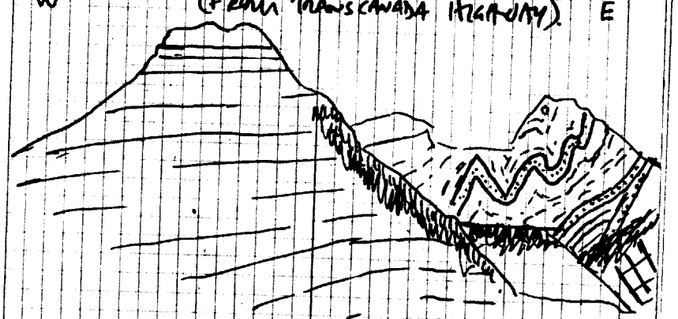
8/25/95

FOOTHILLS SOURCE ROCKS: EXSHAW & KOOTENAY.

STOP 18 - BOURGEAU THRUST IN SAWBACK 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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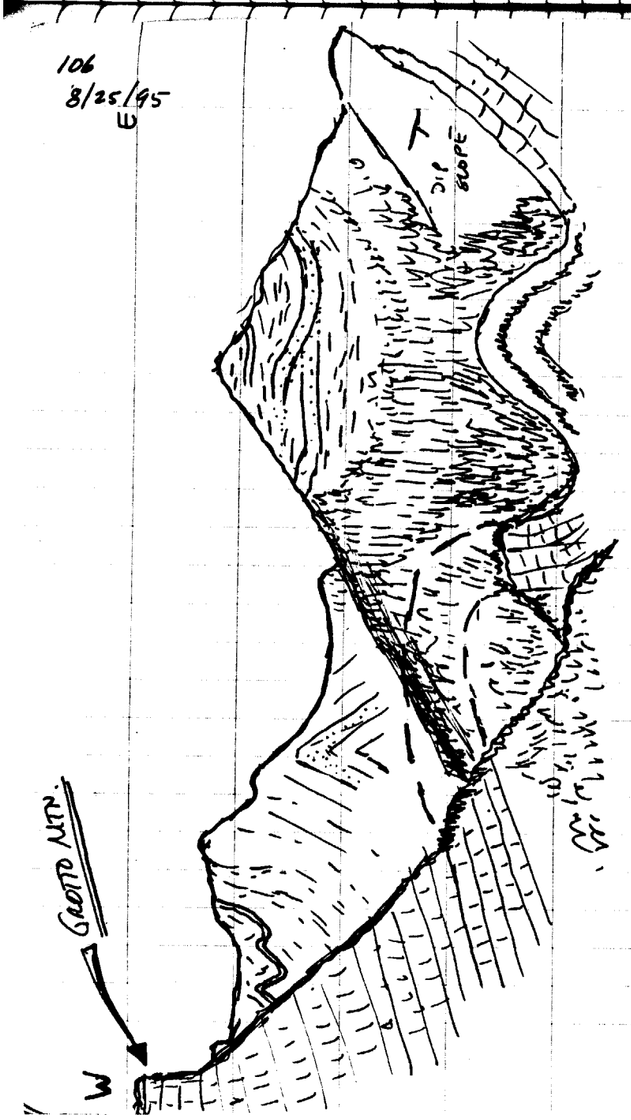

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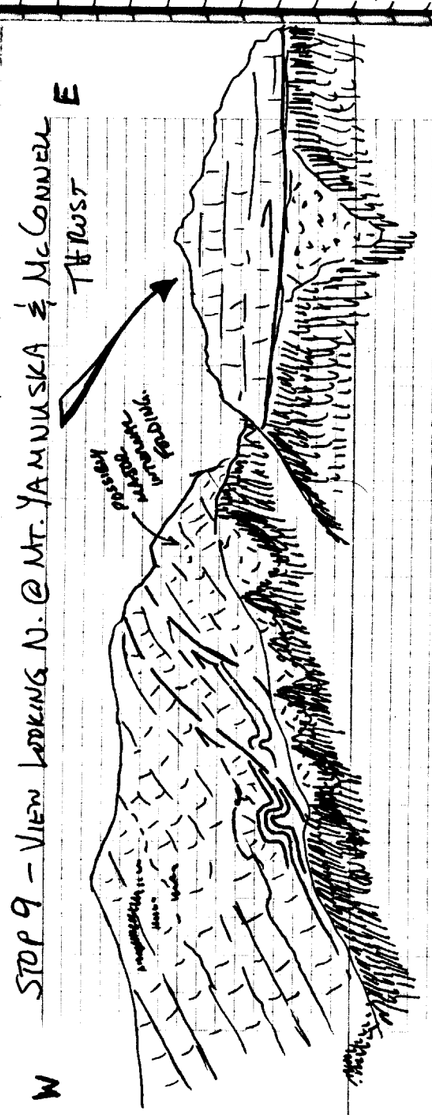
8/25/95



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

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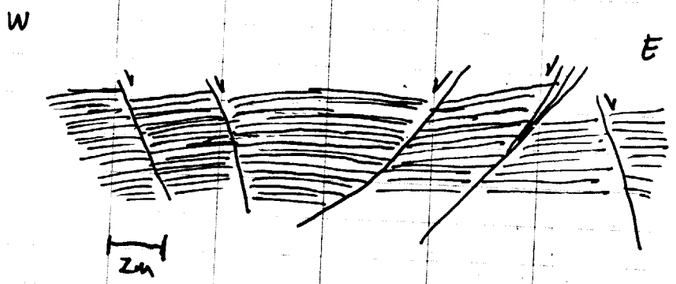
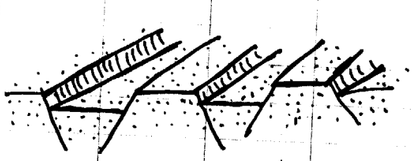
8/25/95

UNOFFICIAL STOP @ SEEBE DAM
NEAR STOP 9.



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



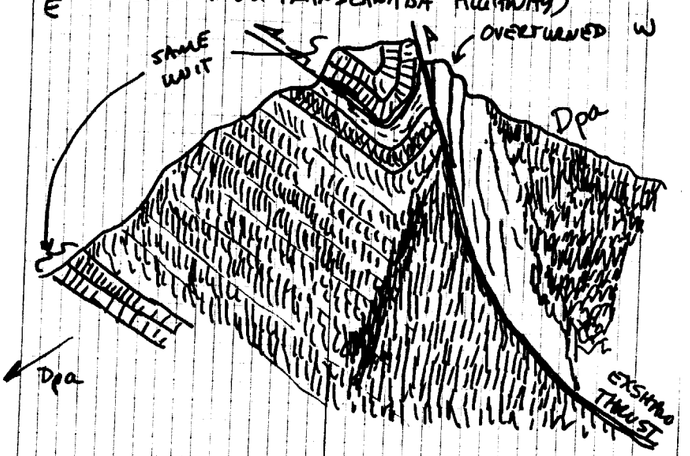
EXTENSIONAL FAULTS CUT SMALL CONTRACTIONAL FAULTS.

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

109
8/25/95

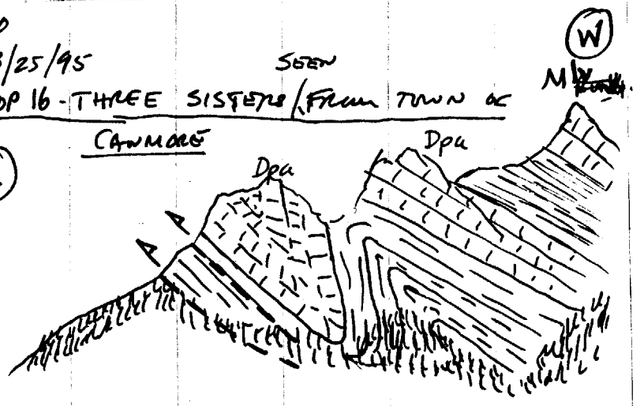
STOP 11 - EXSHAW THRUST AT HEART MOUNTAIN

HEART MOUNTAIN
(VIEW FROM TRANSCANADA HIGHWAY)



110
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 58 - ANTELOPE VALLEY FORMATION.

COARSE GRAINED LIMESTONE SAMPLED FOR MICROSTRUCTURAL ANALYSIS.

DFBM 58A

↑ 011/36 W → MARKED ON TOP BEDDING
BEDDING.

113
13 NOV. 95

DFBM 58B C.G. OAV. → SAME BED AS DFBM 58A

↑ 032/44 W MARKED ON TOP BEDDING.
BEDDING

DFBM 58C - 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 58D -

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

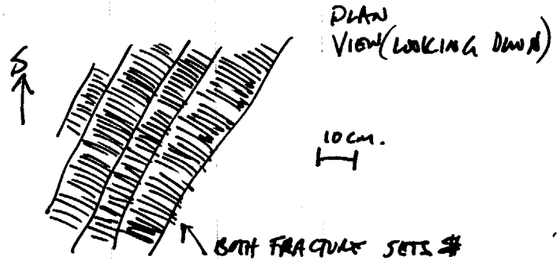
- 3 PIECES THAT FIT TOGETHER NICELY
- COLLECTED FOR ~BED-11 VEIN

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 ⊥ FRACTURE SETS.



115
14 NOV. 1995

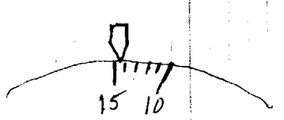
BARE MOUNTAIN, NEVADA.

STAYING AT BULLFROG INN, BEATTY, NEVADA.
PERFECT WEATHER

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

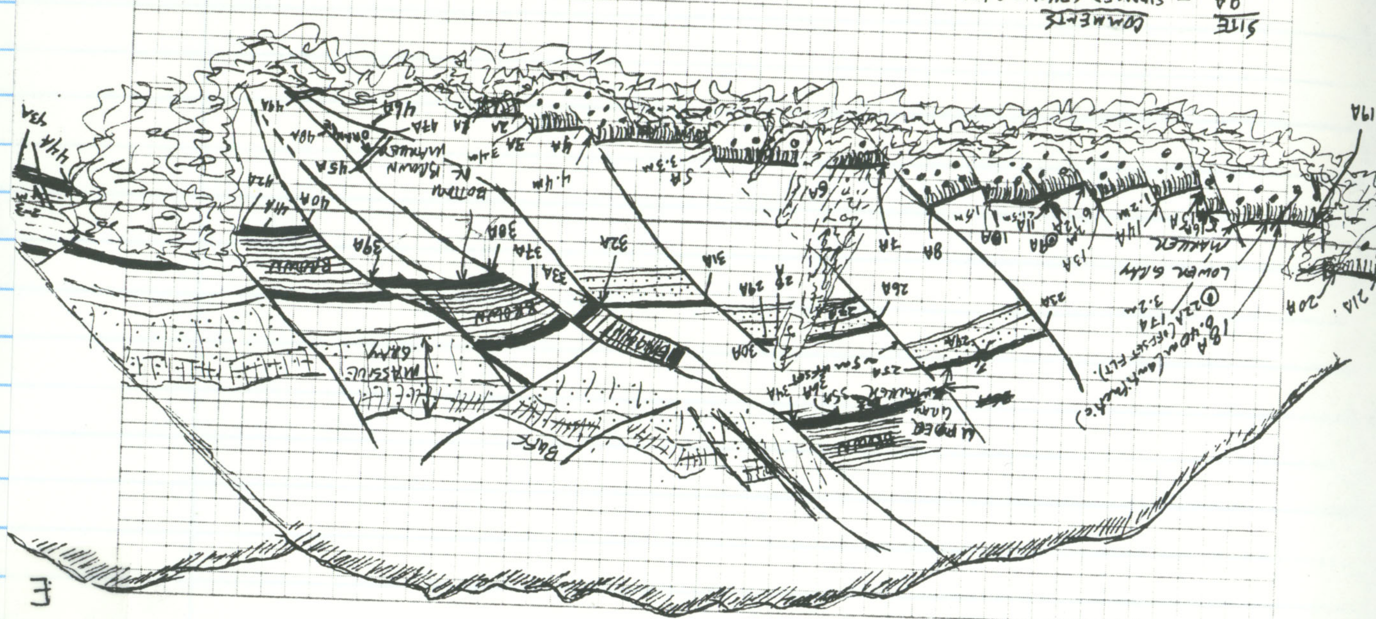
— ALAN MORRIS, SID JONES & DAVID FERRILL MAPPING FAULTS, USING PLANE TABLE & ALIDADE, IN CANYON NORTH OF CARRARA CANYON ~1 MI. DUE EAST OF GOLD ACE MINE ON WEST SIDE OF BARE MTN.

NOTE: COMPASS DECLINATION SET TO 14.5°



117

14 Nov. 1995

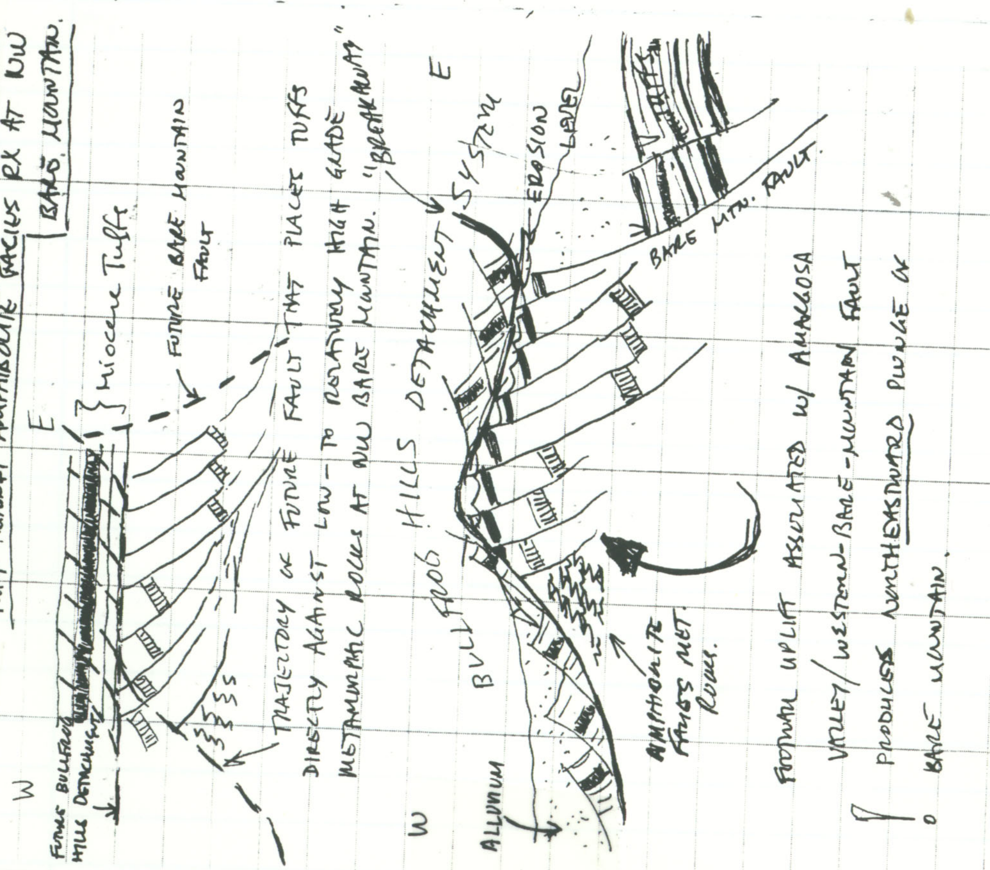


SITE	COMMENTS
9A	SHEARED STYLOLITES IN UNIT ABOVE LOWER GRAY MARKER
14A	VEINS AND OOIDS.
15A	CRUSH ZONE ALONG FAULT (CALICHIFIED)
19A	CLEAVAGE AND DEFORMED STYLOLITES
22A	SMALL FAULTS OFFSET BY LAYER-PARALLEL SLIP
23A	PLETHORA OF SHEARED STYLOLITES.
24A	MIDDLE GRAY MARKER IS OOLITIC HORIZON. CONTRACTION FAULT w/ 1.6m OFFSET. STYLOLITIC CLEAVAGE DOWN AND WEST SEVERAL METERS.
32A	INTERSECTING DEFORMATION. ANTITHETIC FAULT w/ CLEAVAGE VERGING AWAY FROM FLT.
40A	POSSIBLE SLIP ON FOOTWALL BDG.
46A	FAULT OFFSET BY BEDDING (PENROSE POSTER PHOTO)

116

14 Nov. 1995

MODEL FOR FAULT THAT JUXTAPOSES TUFF AGAINST AMPHIBOLITE-FACIES RX AT NW BARE MOUNTAIN.



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

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.

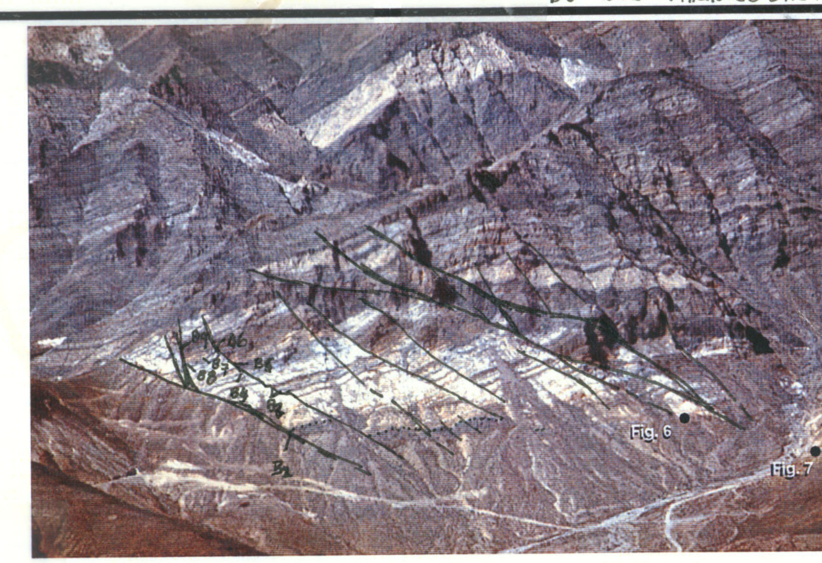


Figure 4. Oblique areal photograph of western Bare Mountain northwest of Carrarra Canyon.

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

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

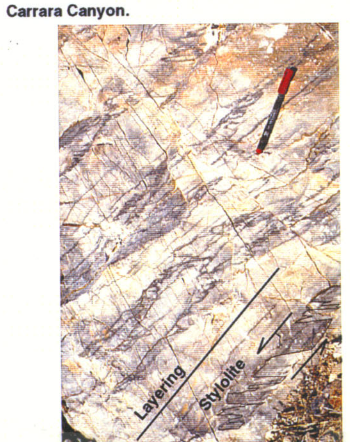


Figure 7. Stylolites in marble sheared in down–dip direction.

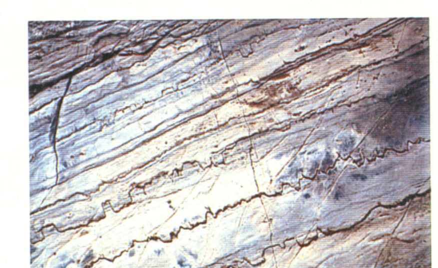


Figure 8. Undeformed stylolites suggest that down–dip layer–parallel shear is not uniformly distributed.

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

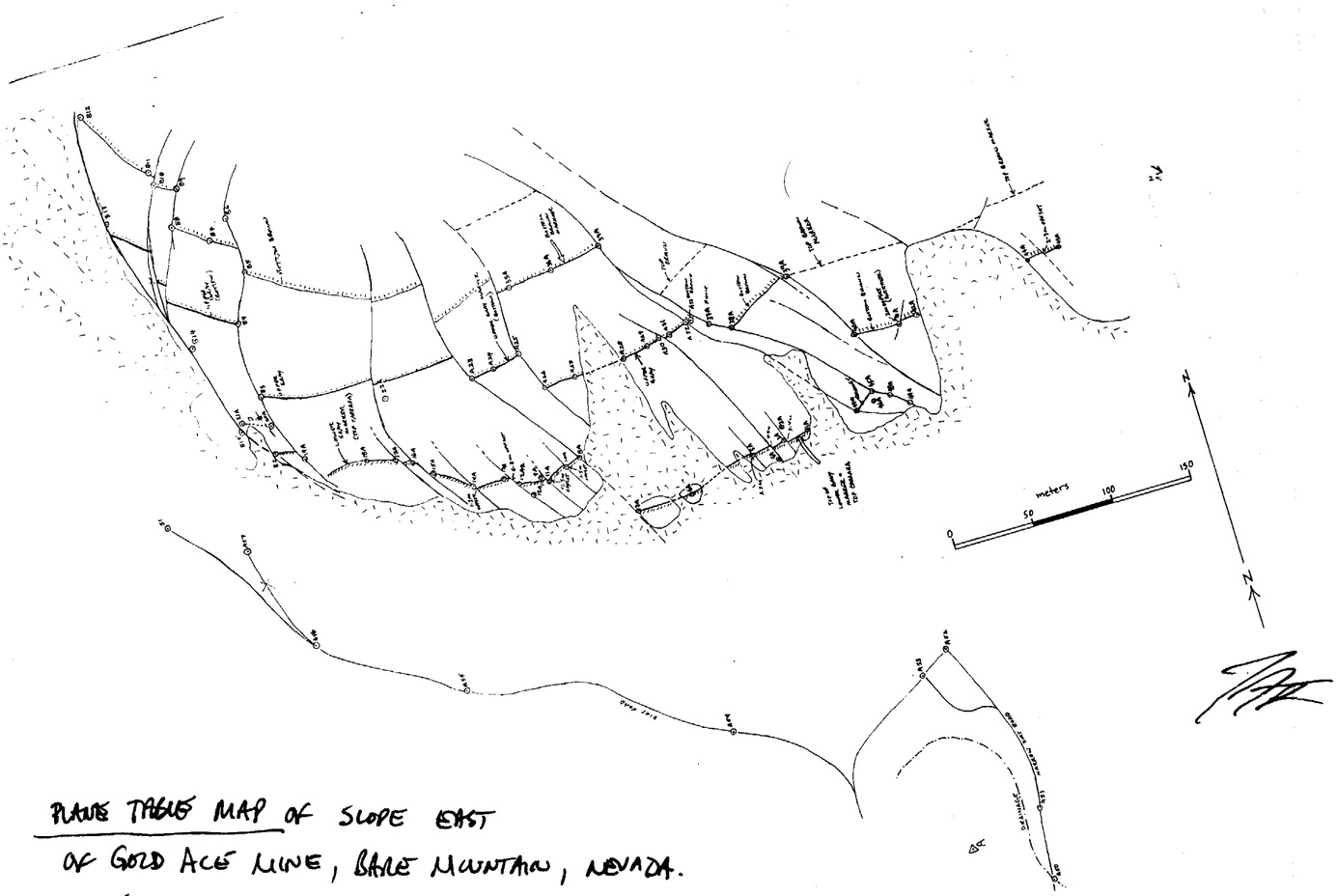
MAPPING FAULTS IN CANYON DUE EAST OF GOLD ACE MINE - WESTERN BARE MOUNTAIN

→ 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.



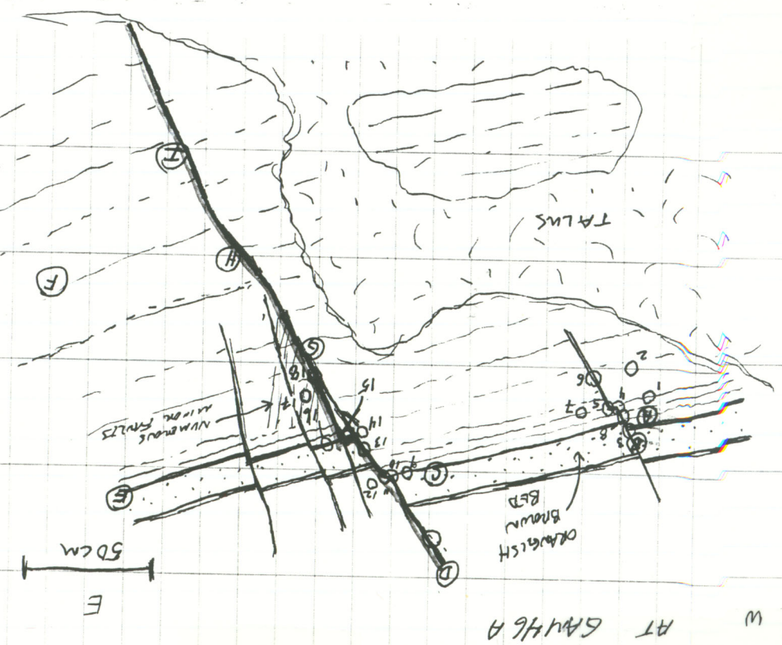
PLANE TABLE MAP OF SLOPE EAST OF GOLD ACE MINE, BARE MOUNTAIN, NEVADA.
(SEE SUPPORTING DOCUMENTATION IN NOTES OF SIDNEY JONES AND ALAN MORRIS.)

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 BEDDING CHANGE DECLINATION IS SET TO 14.5°.

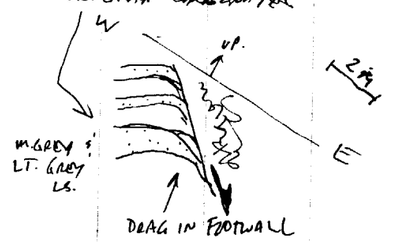


FIELD SKETCH OF FAULTS AND OLDEST ROCKS AT GAVILAN

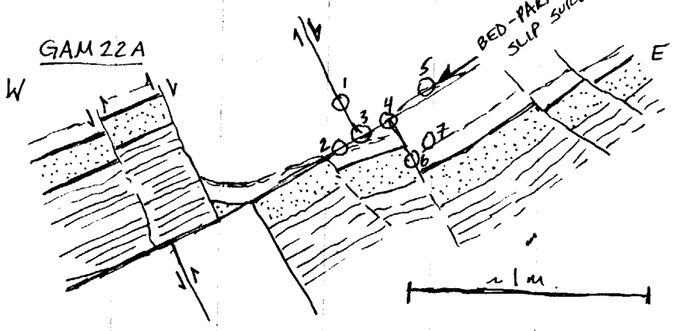
122

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 BACKED IN SCARP 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

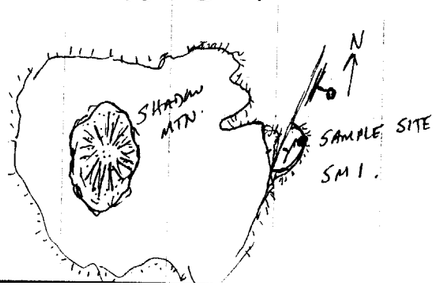
SAMPLING FOR Ar/Ar DATING AND P'MAG REVERSAL STUDIES — SAN FRANCISCO VOLCANIC FIELD.

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 WHICH CHEMICAL ANALYSES AND Ar/Ar DATING WAS DONE.

CR-1 (Cedar Ranch 1) — 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 NEAR 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 STAMP. 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 - PHENOCRYST 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 SIDE OF ~6122' BENCH MARK, ~ 1/2 MI. EAST OF TUB RANCH.

TW1-1, TW1-2, TW1-3 } SAMPLES FOR PMAG ANALYSIS (ORIENTATIONS RECORDED BY J STAMP.)

TW1-4 — SAMPLE FOR DATING.

128

~~MAY~~ MAY 1996.

YUCCA MOUNTAIN REGION, NEVADA

AFTER AAPG MEETING IN SAN DIEGO, CA.

MET SID JONES AND BRET RAWE 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.
+ 076/50S 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 (0.5-10 cm 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 WASH RAW - 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 BED. TOP BEDDING. (STRATIGRAPHIC BOTTOM)

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

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

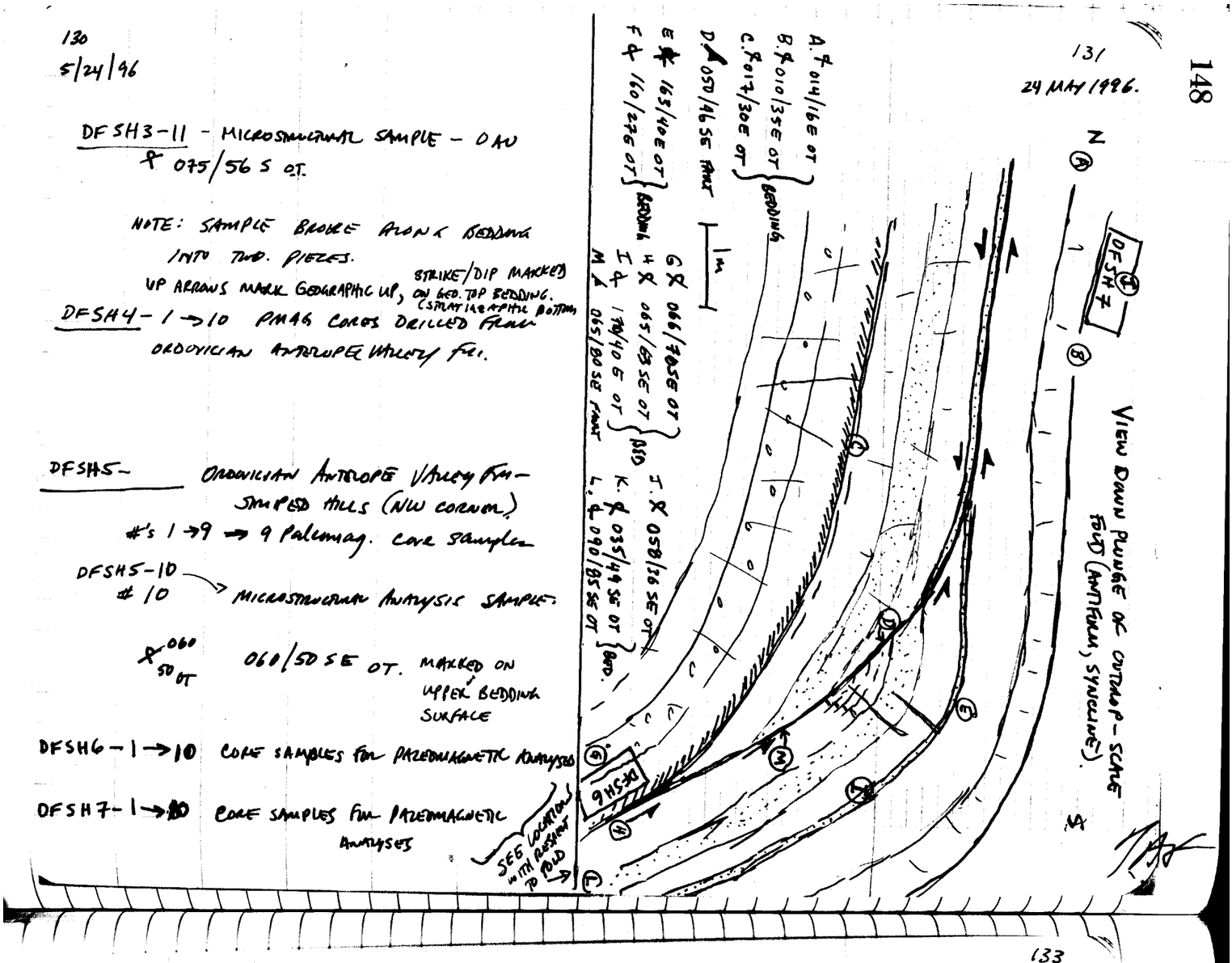
DFSH5-10 → MICROSTRUCTURAL ANALYSIS SAMPLE:
#10

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

DFSH6 - 1 → 10 CORE SAMPLES FOR PALEOMAGNETIC ANALYSES

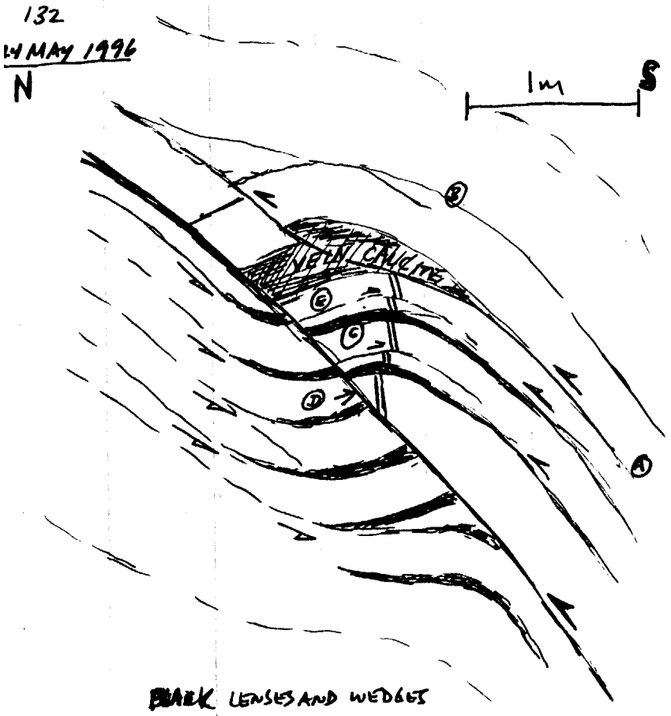
DFSH7 - 1 → 10 CORE SAMPLES FOR PALEOMAGNETIC ANALYSES

SEE LOCATIONS IN ITH RESPECT TO ROAD →



131
24 MAY 1996.

132
24 MAY 1996



BLACK LENSES AND WEDGES AN SIMILAR 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

133
25 MAY 1996

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

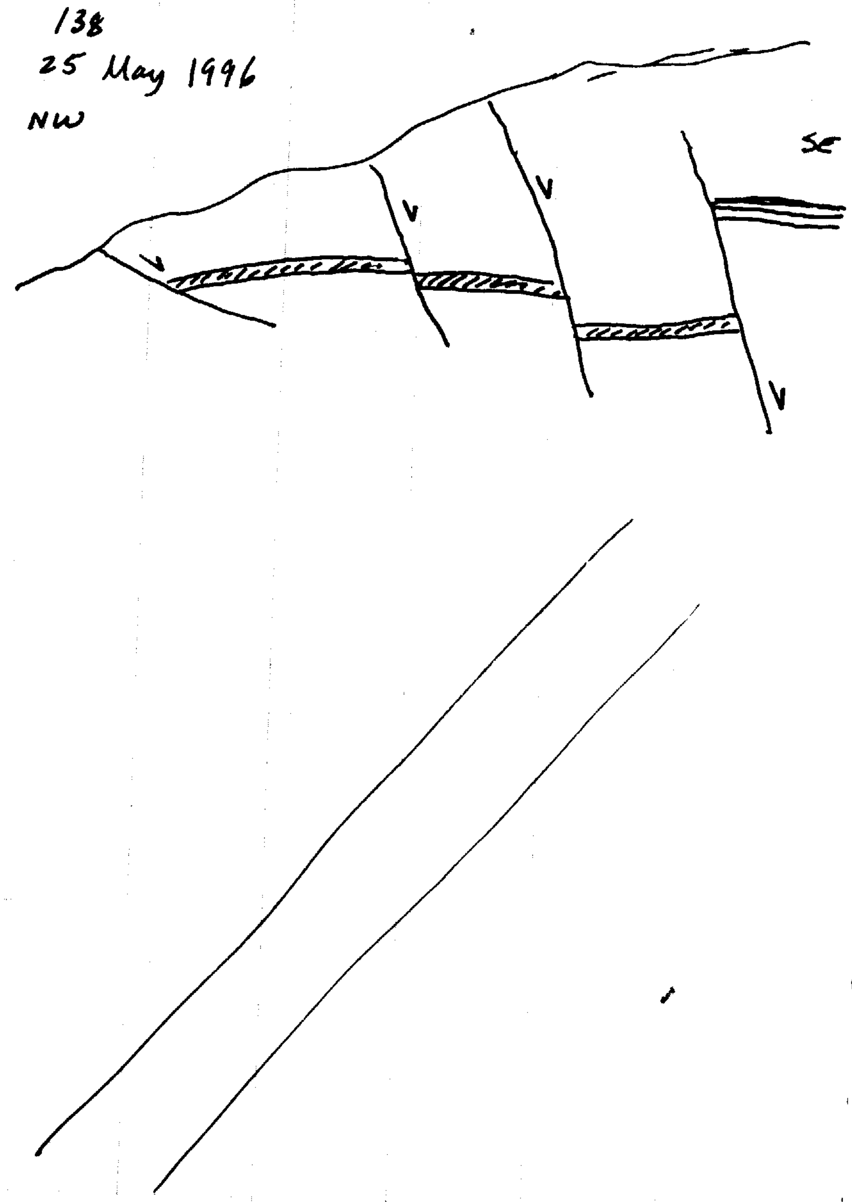
DFYF7 ORDOVICIAN EUREKA QUARTZITE COLLECTED FOR FISSION TRACK ANALYSES

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



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

↳ ALAN 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.
- LOTS OF PHOTOGRAPHS.
- EXCEPTIONALLY LONG BUMPY RIDES PROBABLY TO LONG FOR ADVANCED STRUCTURE FIELD COURSE.

141
28 MAY 96.

BARRICK BULLFROG 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

DFBFM1.1 ← Bullfrog Mine — Main ore unit (Calcite, Qtz, Mn.)
DFBFM1.2 ← Green brecciated, associated w/ main seam
DFBFM1.3 } veins
DFBFM1.4 } mineralization
DFBFM1.5 — Green w/ thin faults and fractures

At Bullfrog Mine main pit (Ladd Peak)

② Montgomery Mtn. — Contact fault w/ basalt flows and dike at intersection (high angle) w/ 2 intersecting faults. NE-SW trending

③ West of Rhyolite

DFBFH1 → [→ Pz carbonate, → Early Tertiary? Gravel, → Tuff, → Qtz latite] ← Samples for microstructural analyses — not oriented.

143
28 MAY 96

DFBM60 -

Carbonate breccia from low hill immediately south of Black Marble Mtn. — not oriented

DFBM61 -

Quartzite samples from south end of Black Marble

Collected for fission track analyses.

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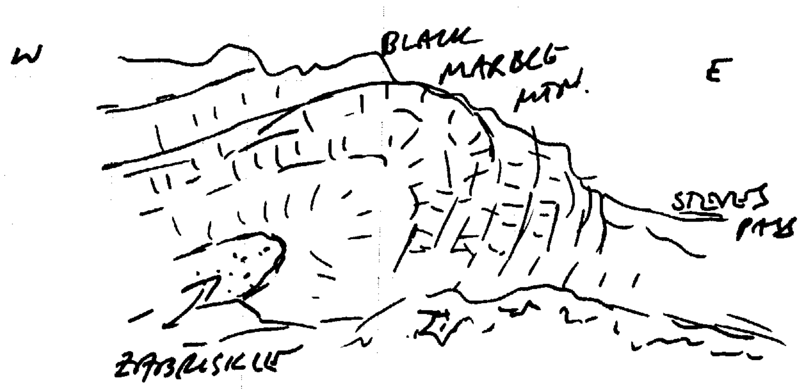
28 May 1996

DFBM 62 -

Zabriskie Quartzite sample from low hill of Zabriskie Qtzite in core of Black Marble east-vergent [illegible] anticline.

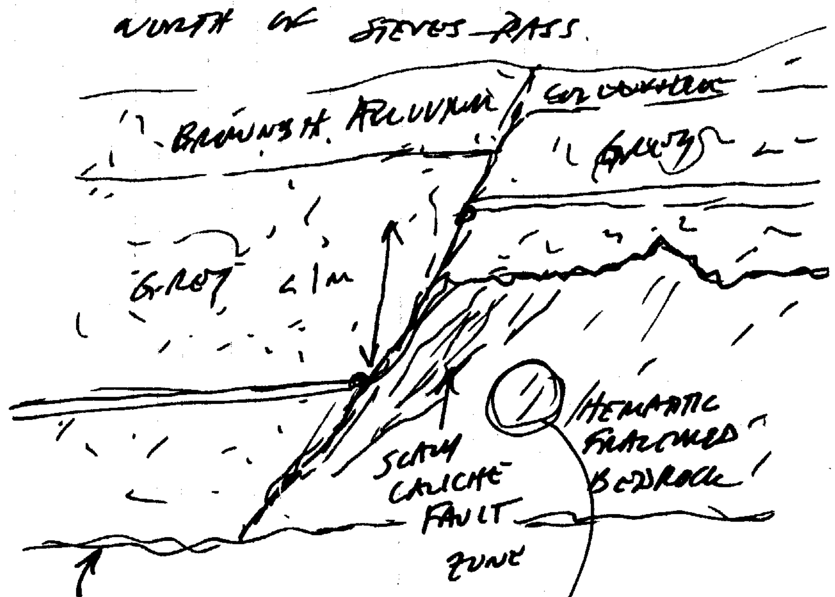
Sample collected for fission track analyses



View N. at Fluid Pressure 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-structures, deformation fabrics & mineralization

146
29 MAY 1996

— 29 MAY 1996.

- BEATTY NEVADA, BURRO 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 TERTIARY ALLUVIUM, COPPER CANYON TURTLEBACK, SOUTHERN DEATH VALLEY, CONFIDENCE HILLS, SARATOGA SPRINGS (PC BASEMENT & PC SECTION + PUPFISH!), AVAWATZ MOUNTAINS → WENT TO CAMP NORTH EDGE OF FORT IRWIN AT IRON ORE MINE.

BERNIE TRUXEL'S EXPLANATION POINT ≡ "EXCLAMATION POINT"

→ DROVE BACK TO SHOSHONE.

147
29 May '96.

SUPPER AT BERNIE TRUXEL'S HOUSE:

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

→ UPWARPING PZ STRATIGRAPHY.

→ JOHN COOPER SAYS

PLAYA COTTONWOODS ADJACENT TO BARE MOUNTAIN PROBABLY OK BASED ON STRATIGRAPHY (ESP. CARRARA FM.) [illegible]

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

ALL-WEATHER WRITING PAPER

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2

3

5 August 1996.

Field Work in Yucca Mountain/ Death Valley Region

Persons: D.A. Fernau (CNWRA)
William M. Dennis (Univ. of Texas.)

Purposes: ① Collect fission track samples from Death Valley Extensional Corridor South of Yucca Mtn (outside Death Valley Nat. 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 Fernau 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 - Zabriskie Quartzite Sample (1 large piece) collected for fission track analysis.

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 Spring 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 (Could see 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 side of Large-Block Tester test.

Comparing pavement 2006 map from Sweetkind et al. 1996 KMAG manuscript.

7

6 August 96

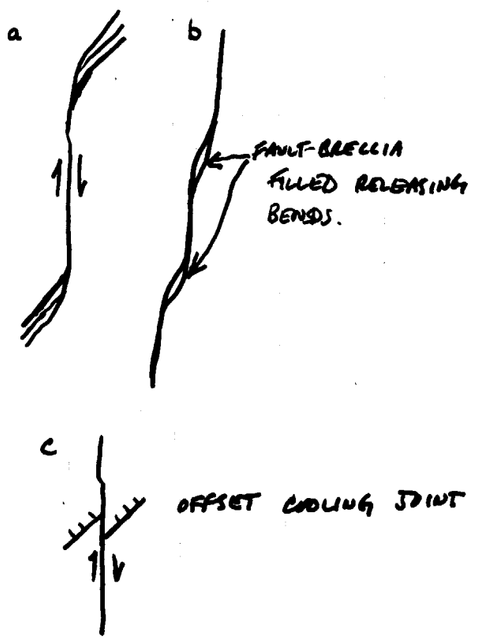
Some observations from Fran Ridge pavement -

- 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 darker finer grained(?) texture on mm scale along fracture walls.
- Fractures generally much less curvy (wavy) developed in upper part of exposure where soil-based sieved lithophysal units are quite abundant.

8

6 August 1996.

- several fractures (particularly those trending 000 – 350). have been reinterpreted as right-lateral strike-slip faults.



a, b, c illustrate indications of right slip seen in outcrop

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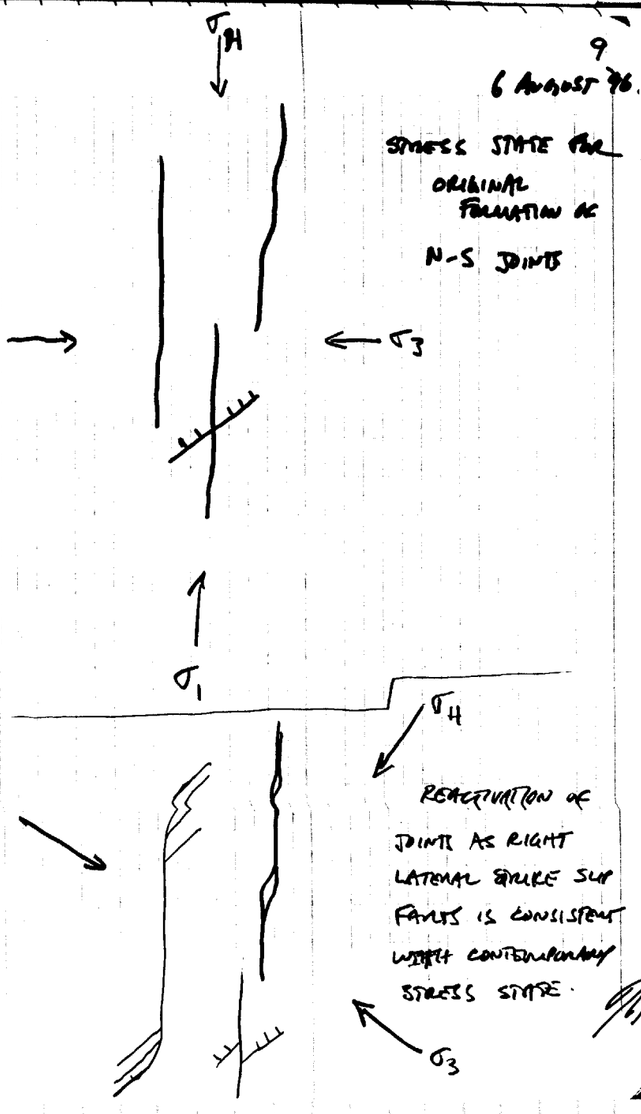
6 August 96.



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.
- FEW HORIZONTAL CUMULATED/COLLAPSED LITHOPHYSAE COMMONLY REMAIN OPEN AS VUGS — SOME ARE CONNECTED BY SUB HORIZONTAL FRACTURES.

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6 Aug. 1996.

- RADIAL SWARMS OF FRACTURES ARE COMMON IN LITHOPHYSAE (10% OF CAV 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 MOSSY TEXTURE & ABUNDANT LITHOPHYSAE (NOT AS COLLAPSED AS LOWER IN FOOTWALL OR HANGINGWALL), AND IS LESS PERVASIVELY FRACTURED THAN BETTER-WELDED ROCKS DEEPER IN FOOTWALL.

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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.

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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 ORIENTATIONS: 88 / 140

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

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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 & strike slip.

After departing ESF → photo's @ UZ Fa and P2001 → Bill Dunne's field notes.

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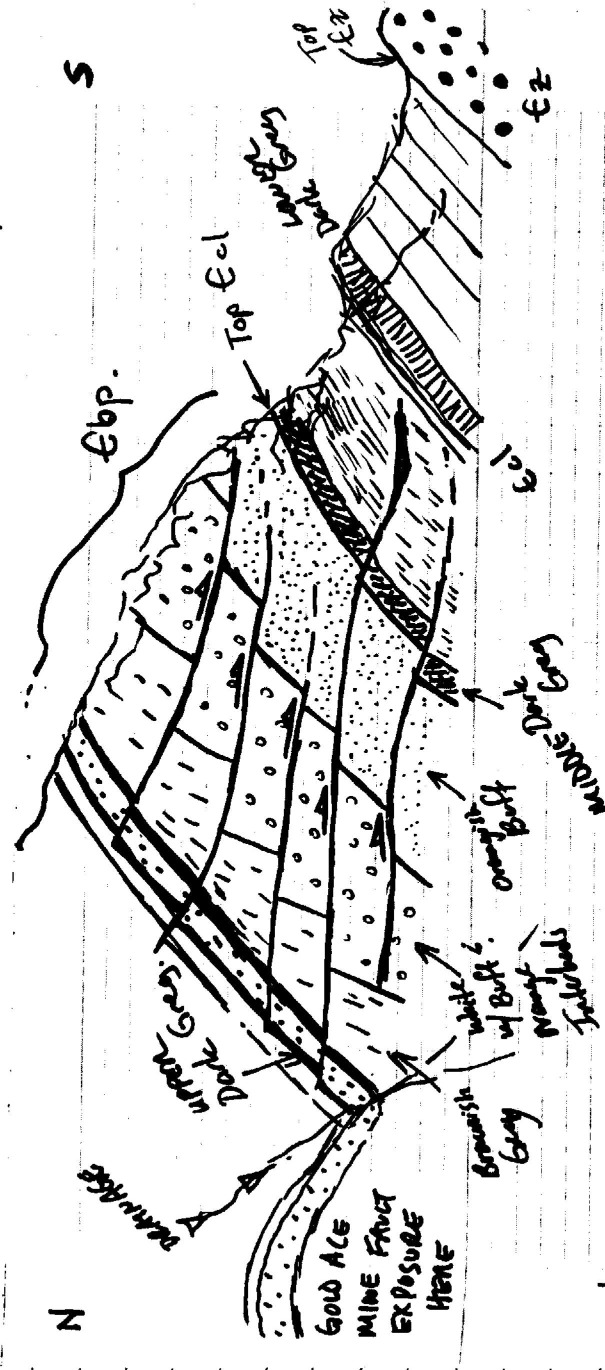
7 August 1996.

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 whitened Ꞓca (middle member of Carrara).



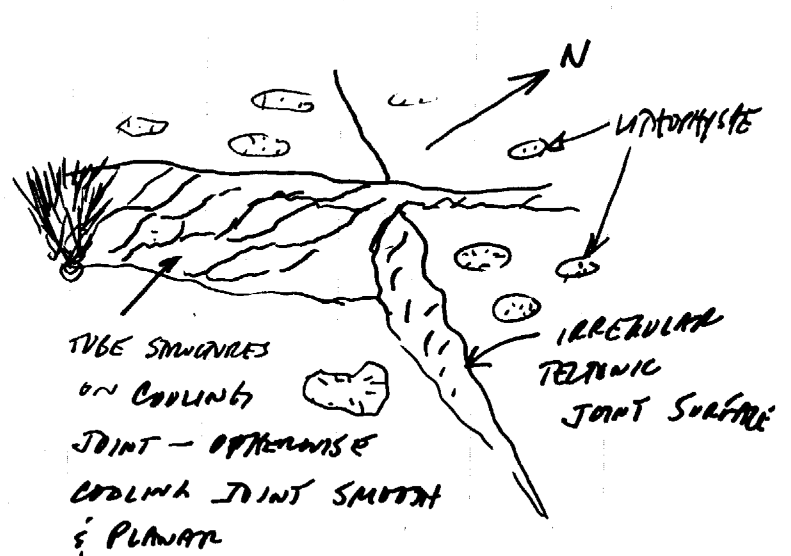
16
8 August 1996.

Field Reconnaissance @ Yucca Mtn.

William M. Dunne
David A. Ferrill

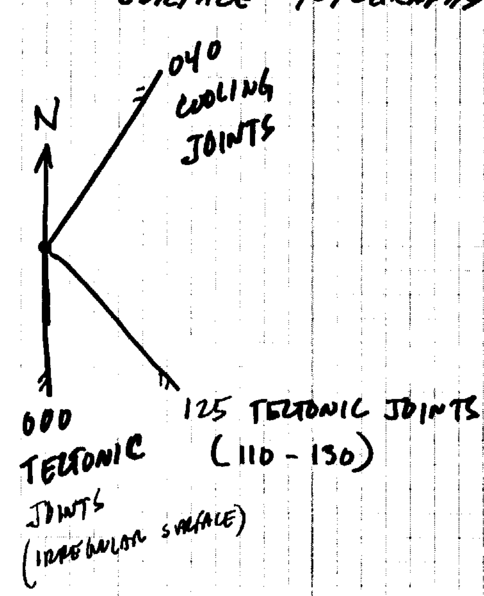
Tonsil Ridge Pavement

Rock pavement on Tonsil Ridge on CR1 (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.



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8 AUGUST 1996

PAVEMENT 100 -

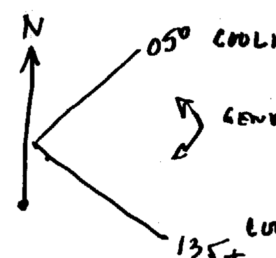
UPPER LITHOPHYSAL (TIVA CANYON)
BETWEEN SPLIT WASH AND COYOTE
WASH ON LIVE YUCCA RIDGE

- SWARM OF 050-TRENDING COOLING JOINTS (8-9 JOINTS SPACED WITHIN 4m HORIZONTALLY).

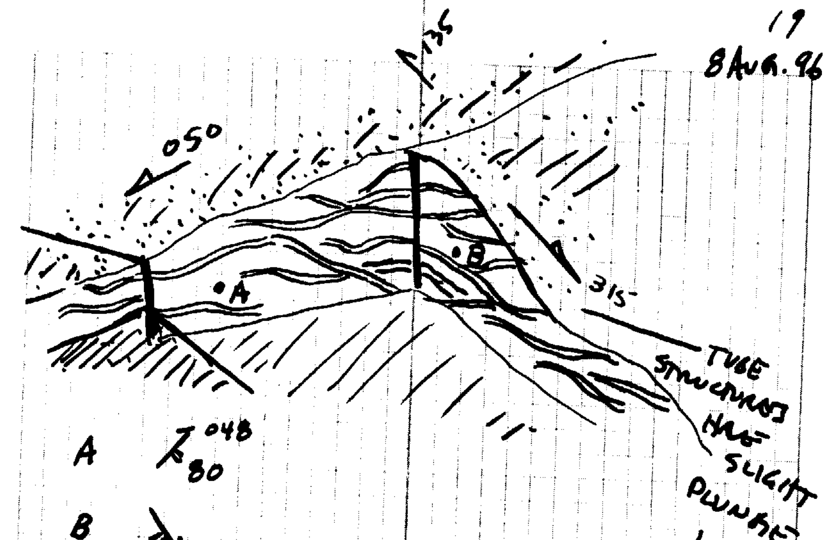
- COOLING JOINTS HAVE WELL-DEVELOPED TUBULAR STRUCTURES ON SURFACES.

- PERPENDICULAR (~135°) COOLING JOINT ABUTS AGAINST 050 COOLING JOINTS AT EACH END.

- INTERSECTION OF 050 & 135 COOLING JOINT NOT VERTICAL.



19
8 AUG. 96



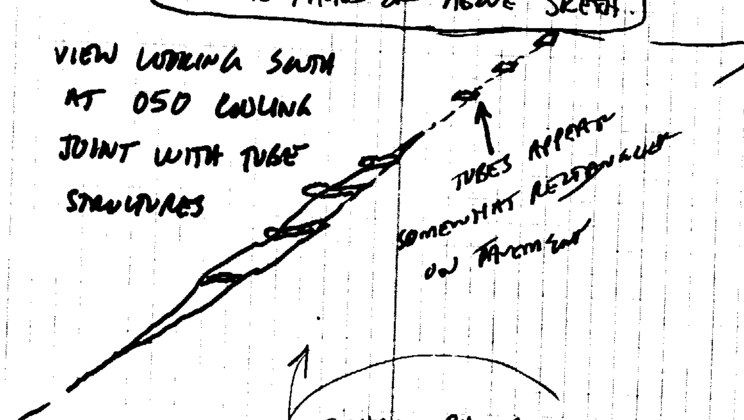
A 048 / 80

B 79 / 133

NOT EXPLAINED BY EAST DIP OF LAYERING

SEVERAL PHOTOS OF ABOVE SKETCH.

VIEW LOOKING SOUTH AT 050 COOLING JOINT WITH TUBE STRUCTURES



SEVERAL PHOTOS

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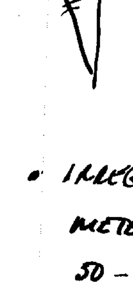
8 AUGUST 1996.

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

LOWER OR PERHAPS MIDDLE LITHOPHYSAL OF TIVA CANYON.

- PAVEMENT ~150m LONG, 10m HIGH.
- 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 OF PAVEMENT — MAY BE DUE TO UNLOADING.

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8 AUGUST '96

- SEVERAL HORIZONTAL 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 PRESENCE OF BRECCIA ZONES AND ZONES OF INTENSE FRACTURING CONTRAST SHARPLY W/ TOPSIC RIDGE PAVEMENT AND PAVEMENT 100.
  - ADDITIONAL DEFORMATION AT A.R.P. PROBABLY OVERPRINTS EARLY COOLING & TECTONIC JOINTS.

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8 August.

ANALYSE WD

- IF 330-240 JOINT SET DEVELOPED RELATED TO GHOST DANCE FAULT, THE ~ VERTICAL INTERSECTION WOULD SUGGEST STRIKE - SLIP DEFORMATION.

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

YUCCA CREST - ~~Xcr2~~ Tiva Canyon Tuff ; cr1

THROCKMORTON AND VERBEEK STATION 1959 No. 1 (BENCHMARK)

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

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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, CUTBANKS STUDIES) 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 STRUCTURE
  - SMOOTH PLANAR CUTTING LITHOPHYSAE
  - ROUGH CURVIPLANAR ANASTOMOSING AROUND LITHOPHYSAE
  - SUBHORIZONTAL ROUGH
  - SUBHORIZONTAL SMOOTH PLANAR.

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9 Aug. '96.

- DISCUSS REACTIVATION
  - BRECCIATION
  - REORIENTING VEINS
  - DILATION (RELATED TO BRECCIATION).
- TABULATE DISCUSS FRACTURE STUDIES ACCORDING TO LITHOLOGY & PROXIMITY TO FAULTS. INCLUDE:
  - PAVEMENTS
  - CUTBANKS
  - 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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9 August '96

(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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9 August 1996
(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 % of dilation of joints due to high 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:

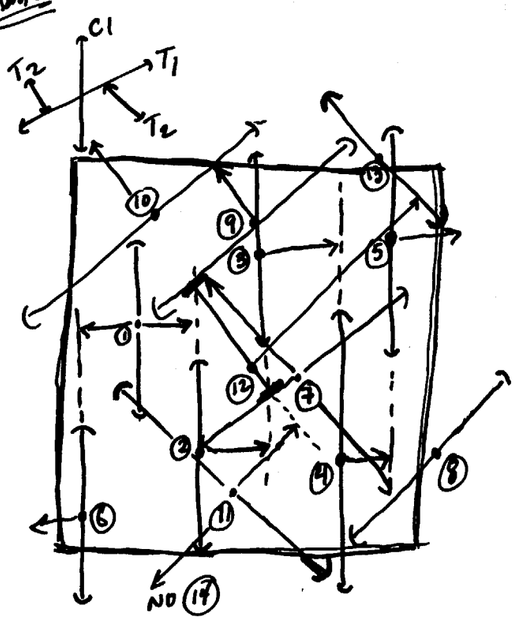
- Can test synthetic by comparing comparing trace length / area from synthetic with length / area from pavement and/or ESF measurements.
- Beware of ranking joints according to abundance as was done by Throckmorton & Verbeek (Earl & Connie). As we saw at Fran Ridge pavement (2001) there were a few subhorizontal 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 a

30

9 August 1996

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, NOW MARTIN, M. CONWAY.

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

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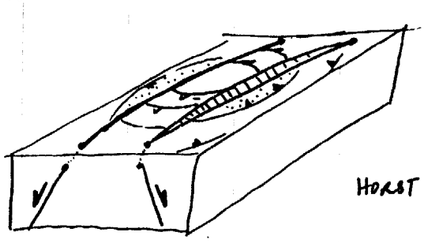
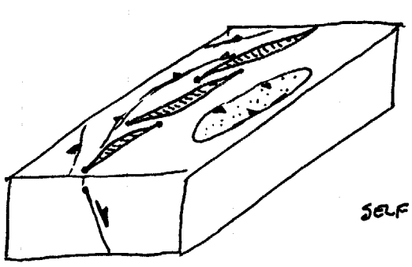
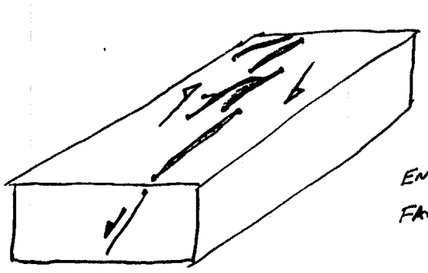
5 NOV. '96



HORST



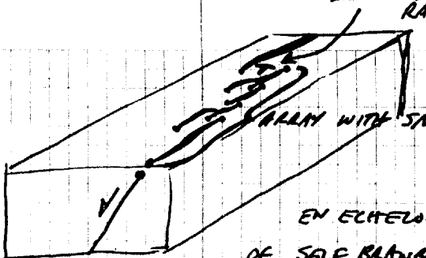
SELF BRANCHING FAULT (EN ECHELON BRANCHING)



EN ECHELON FAULT ARRAY

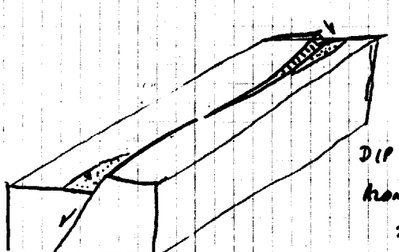
LARGER RELAY RAMPS

5 NOV '96

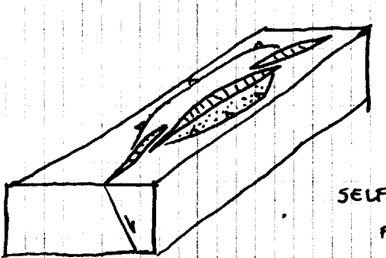


ARRAY WITH SMALL RELAY RAMPS

EN ECHELON ARRAY OF SELF BRANCHING FAULTS



DIP REVERSAL ALONG FAULT SYSTEM.



SELF BRANCHING FAULT

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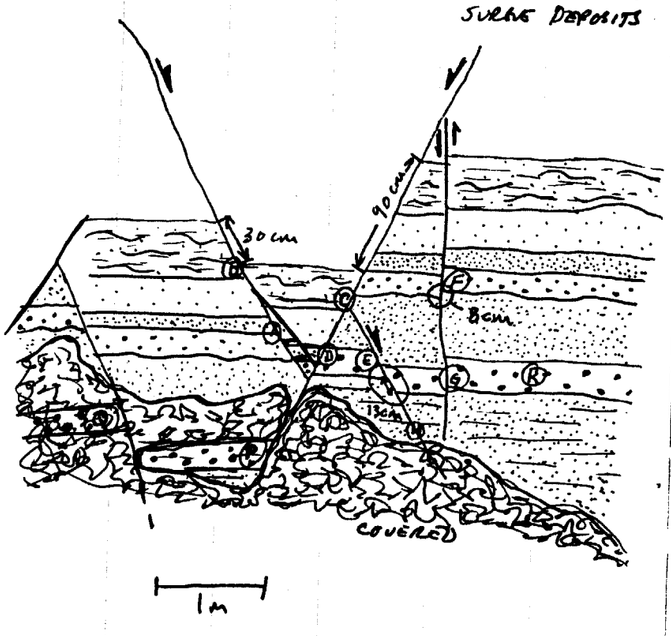
6 NW. 1996
WEDNESDAY

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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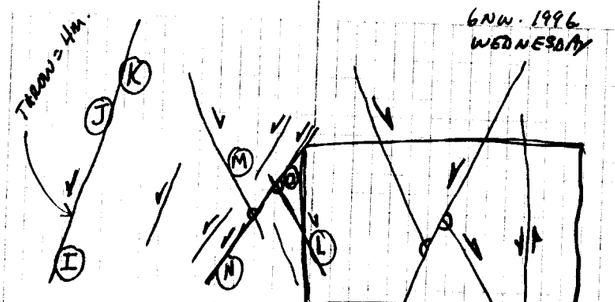
6NW. 1996
WEDNESDAY



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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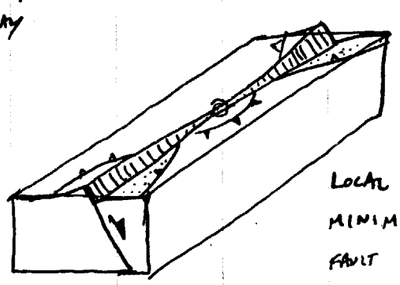
7 NW. 1996
THURSDAY



LOCAL DISPLACEMENT MINIMUM ALONG FAULT

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8 NW. '96

IDEAS FOR FIELD COURSE AND FAULT ANALYSIS OF VOLCANIC TERRAIN.

- 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 AIR SOUTH OF RED ROCKS.
- 3D MOVIE 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 CATTLE BLUFF EXPOSURE INTO CROSS SECTION.
- RESTORE CATTLE BLUFF OUTCROP CROSS SECTION.
- EMPHASIZE/ILLUSTRATE CROSS SECTIONAL STRUCTURAL STYLE AT CATTLE BLUFF EXPOSURE. INTERPRET CROSS CUTTING RELATIONSHIPS.
- CONSIDER USS VS OSS VS PURE SHEAR VS OUTER-ARC EXTENSION AT CATTLE BLUFF.
- EXTRACT SERIAL PROFILES FROM GPS 3D MODEL FOR [illegible] EXERCISE.
-
- INTERPRET FAULTS FROM SATBED DEM (LOW RES), GPS GENERATED DEM, & SLAR (POSS. AIR PHOTOS).

~~EA~~

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- 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 BRANCHING FAULT (EN ECHELON BRANCH)
  - EN ECHELON ARRAY OF FAULTS.
  - OBLIQUE- & HIGH-ANGLE FAULT INTERSECT.
  - 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

H. Lawrence McKague
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 LOCATIONS MARKED 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

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Data Sensitivity:	■"Non-Sensitive" □ Sensitive □"Non-Sensitive - Copyright" □ Sensitive - Copyright
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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