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Scientific Notebook #114
Supporting the Hydrology
Research Project

Hydrology Research Project
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Project Title: Regional Hydrology Research 20-5704-~~163~~ BW 8-5-94
PI: Gordon Wittmeyer x5082 131

Objective: Data processing, analysis, fusion, and visualization of hydrologic data to produce products for investigators to utilize in conducting hydrologic analysis.

Current projects tasks have included investigations of relationship of maximum horizontal stress and flow directions. Utilized stress data from World Stress Map (USGS) and topographic data from USGS DEM (3-arcsecond resolution) databases. USGS DEMs can be found on edcftp.cr.usgs.gov. Also used well data from Nevada Test Site (NTS) to model hydro surface.

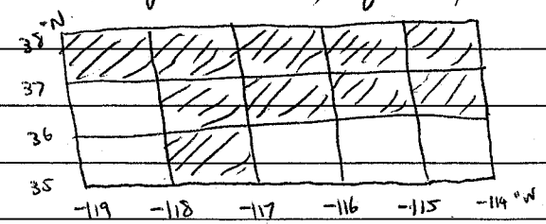
Investigations involved comparing flow directions based only on well-recorded depths versus effects on maximum horizontal stress in Yucca Flat region. Hypothesis is that taking horizontal stress orientations into account effects expected direction of water flows.

Brent Hinkson
8-5-94

Task: Create Shaded-Relief DEMs with Hydrography Streams Lines Overlaid.

Data Sources: DEMs — USGS 3-arcsec ftp edcftp.cr.usgs.gov
Streams — ARC/INFO GIS database
/u6/gisdb/d2016/hydro/streams/reg68utm/rawlines

Area already produced:



New areas desired: lat: 38-39° N
lng: -119 to -114 °W

Retreived existing files from opto cartridge OPTOBHO6A
/opto/brent/hydroLines

Brent Harker 8-26-94

HydroLines	Lng	Lat	USGS Fiber	Elev MIN	MAX
Cell SW Corner	-115°W	38°N →	Lund-e	1487	3961
	-116°W	"	Lund-w	1414	3501
	-117°W	"	Tonopah-e	1467	3631
	-118°W	"	Tonopah-w	1366	3570
	-119°W	"	Walker-lake-e	1218	3415

Streams coverage in ARC/INFO GIS DB:
/u6/gisdb/d2016/hydro/streams/reg68utm/rawlines

	geo	pixels	rate
dem 48 cells	-120 — -114°W	1806	301/1°deg
	32 — 40° N	2408	301/1°deg

- Have students check gbot.out + gwlo.fil to check runExtract3 script

- Revised runExtract3, awk script to extract data from well file + extract depth data. Found bug that caused first depth to be duplicated. Ran pointCheck to find wells in DV03 area.

Brent Harker 8-30-94

Filter Script to Extract Dates from hydro wells files:

runExtract3 Page 1

```
#!/bin/sh
awk ' { if ($1 == "C001") {
          wellId = $NF
          for (i = length(wellId); i < 15; i++)
             wellId = wellId " "
          latOk       = 0
          lngOk       = 0
          altitudeOk  = 0
          depthT1Ok     = 0
          depthT1DateOk = 0
          depthT2Ok     = 0
          depthT2DateOk = 0
          lastDate    = 19999999
       }
     }
     { if ($1 == "C009") {
          lat = $NF
          if (length(lat) == 6) {
             lat = substr(lat,1,2)+substr(lat,3,2)/60.0+substr(lat,5,2)/3600.0
          } else {
             lat = substr(lat,1,3)+substr(lat,4,2)/60.0+substr(lat,6,2)/3600.0
          }
          latOk = 1
       }
     }
     { if ($1 == "C010") {
          lng = $NF
          if (length(lng) == 6) {
             lng = substr(lng,1,2)+substr(lng,3,2)/60.0+substr(lng,5,2)/3600.0
          } else {
             lng = substr(lng,1,3)+substr(lng,4,2)/60.0+substr(lng,6,2)/3600.0
          }
          lng *= -1.0
          lngOk = 1
       }
     }
     { if ($1 == "C016") {
          altitude = $NF
          altitudeOk = 1
       }
     }
     { if ($1 == "C030") {
          depth = $NF
          depthT1Ok = 1
          depthT2Ok = 0
       }
     }
     { if ($1 == "C031") {
          depthDate = $NF
          for (i = length(depthDate); i < 8; i++)
             depthDate = depthDate " "
          depthT1DateOk = 1
          depthT2DateOk = 0
       }
     }
     { if ($1 == "C235") {
          depthDate = $NF
          for (i = length(depthDate); i < 8; i++)
             depthDate = depthDate " "
          depthT2DateOk = 1
          depthT1DateOk = 0
          depthT2Ok = 0
       }
     }
     { if ($1 == "C237") {
          depth = $NF
```

BH
8-31-94

runExtract3 Page 2

```
          depthT2Ok = 1
          depthT1Ok = 0
       }
     }
     { if (latOk && lngOk && altitudeOk && ((depthT1Ok && depthT1DateOk) || (de
pthT2Ok && depthT2DateOk))) {
          if (lastDate != depthDate) {
             relDepth = altitude - depth
             lineCnt += 1
             printf "%5d  %s  %10.5f  %10.5f  %8.2f  %s \n", \
               lineCnt, wellId, lat, lng, relDepth, depthDate
             lastDate  = depthDate
          }
          depthT1DateOk = 0
          depthT2DateOk = 0
       }
     }
   ' $1
```

Brit Hankins 8-31-94

Sample input records from wells data:

nts.in Page 3

```
 C172   Name of spring                                  CORN CREEK RANCH SPRIN
G
 C727   Record number for spring subrecord                1
 C764   Record type for SPNG subrecord of CONS file      SPNG
 C765   Last update for SPNG subrecord of CONS file      19930405

 C001   Site ID (station number)                        362624115212701
 C002   Type of site                                    W
 C003   Record classification                            C
 C004   Source agency code                              USGS
 C005   Project number                                  LVHD
 C006   District code                                   32
 C007   State code                                      32
 C008   County code                                     003
 C009   Latitude                                        362624
 C010   Longitude                                       1152127
 C012   Local well number                               212  S17 E59
 C013   Land-net location                               NE S34 T17S R59E M
 C014   Name of location map                            CORN CREEK SPRINGS
 C015   Scale of location map                           62500
 C016   Altitude of land surface                        2930.0
 C017   Method altitude determined                      M
 C018   Altitude accuracy                               10
 C020   Hydrologic unit code                            15010015
 C023   Primary use of site                             O
 C027   Hole depth                                          150.
 C028   Depth of well                                       150.
 C030   Water level                                      23.83
 C031   Date water level measured                       19450511
 C040   Date site record last updated                   19911106
 C303   Date site record created                        19800711
 C712   Data availability in other Ground Water files   YYNNNYNNNNNNNNNNNNN
 C802   Station-type codes                              NNNNNYN
 C900   Station name                                    212  S17 E59
 C068   Depth to bottom of seal                             0
 C723   Record number for construction subrecord             1
 C754   Record type for CONS subrecord of CONS file     CONS
 C755   Last update for CONS subrecord of CONS file     19860205
 C190   Other identifier                                NRSURFACE1
 C191   Assignor of other identifier                    LV WL NET
 C736   Sequence number for OTID subrecord of MISC file      1
 C770   Record type for OTID subrecord of MISC file     OTID
 C771   Last update for OTID subrecord of MISC file     19860206
 C115   Begin year of data collection                    1945
 C118   Frequency of data collection                     I
 C706   Network data type -miscellaneous                WL
 C730   Sequence number for SPEC subrecord of MISC file      1
 C780   Record type for NETW subrecord of MISC file     NETW
 C781   Last update for NETW subrecord of MISC file     19860206
 C235   Water-level measurement date                    19450511
 C236   Date accuracy code -wl                          D
 C237   Water level                                        23.83
 C239   Water-level method                              S
 C276   Accuracy code                                   2
 C235   Water-level measurement date                    19450809
 C236   Date accuracy code -wl                          D
 C237   Water level                                        24.39
 C239   Water-level method                              S
1DATE: 12/09/93          Preliminary data compiled by U.S. Geological Surve
y, Las Vegas, Nevada--SUBJECT                 PAGE   4

 C276   Accuracy code                                   2
 C235   Water-level measurement date                    19451109
 C236   Date accuracy code -wl                          D
 C237   Water level                                        23.49
 C239   Water-level method                              S
```

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8-31-94

Brit Hankins, 8-31-94

Scripts to Remove Duplicate Records:

runRemDups

```
#!/bin/sh

echo Begin

# Arrange
# WAS: line wid   lat   lng   meas  date
#  IS: wid  date  meas  lat   lng
awk '{ print $2, $6, $5, $3, $4 }' $1 | sort > $1.t1

# Arrange
# WAS: wid  date  meas  lat   lng
#  IS: meas wid   date  lat   lng
awk '{ print $3, $1, $2, $4, $5 }' $1.t1 > $1.t2

uniq +8 $1.t2 $1.t3
uniq +8 -d $1.t2 $1.t4

# Arrange   1     2     3     4     5
# WAS:      meas  wid   date  lat   lng
#  IS: line wid   lat   lng   meas  date
awk '{ s += 1 }
     { printf "%5d  %s  %s  %s  %s  %s\n", s, $2, $4, $5, $1, $3 }' \
     $1.t3 > $1.NODUPS

# Arrange   1     2     3     4     5
# WAS:      meas  wid   date  lat   lng
#  IS: line wid   lat   lng   meas  date
awk '{ s += 1 }
     { printf "%5d  %s  %s  %s  %s  %s\n", s, $2, $4, $5, $1, $3 }' \
     $1.t4 > $1.DUPS

rm $1.t1 $1.t2 $1.t3 $1.t4

echo Done
```

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8-31-94

runWells3

```
#!/bin/sh

echo ---------------------------------
echo   Extract gw1.fil
echo ---------------------------------
runExtract3 $DATDIR/gw1.fil > gw1awk3.fil

echo ---------------------------------
echo   Extract gw2.fil
echo ---------------------------------
runExtract3 $DATDIR/gw2.fil > gw2awk3.fil

echo ---------------------------------
echo   Extract nts.fil
echo ---------------------------------
runExtract3 $DATDIR/nts.fil > ntsawk3.fil

echo ---------------------------------
echo   Remove Dups gw1
echo ---------------------------------
runRemDups gw1awk3.fil

echo ---------------------------------
echo   Remove Dups gw2
echo ---------------------------------
runRemDups gw2awk3.fil

echo ---------------------------------
echo   Remove Dups nts
echo ---------------------------------
runRemDups ntsawk3.fil

echo ---------------------------------
echo   Cat files
echo ---------------------------------
cat gw1awk3.fil.NODUPS gw2awk3.fil.NODUPS ntsawk3.fil.NODUPS > wells3.fil

echo
echo Done
```

BH
8-31-94

Brett Harden
8-31-94

Scripts to find Points w/in DV03 boundary:

runPointCheck

```
#!/bin/csh

echo Begin

if ($1 == "DV03") then
   pointCheck \
   -inPolygon dv03.txt \
   -inPoints wells3.fil \
   -outFile wells3InOutDV03.fil
endif

if ($1 == "IN") then
   pointCheck \
   -inPolygon /gscr0/brent/hydro/ps/dv03.txt \
   -inPoints /gscr0/brent/hydro/wellsData/wellsInDV03.fil \
endif

echo Done
```

BH
8-31-94

dv03.txt

-117.58	37.46
-117.58	37.43
-117.66	37.40
-117.65	37.36
-117.70	37.33
-117.71	37.29
-117.68	37.25
-117.67	37.22
-117.63	37.20
-117.62	37.13
-117.62	37.06
-117.58	37.01
-117.61	36.96
-117.57	36.90
-117.62	36.86
-117.59	36.83
-117.62	36.82
-117.61	36.75
-117.59	36.64
-117.57	36.63
-117.47	36.60
-117.48	36.55
-117.51	36.53
-117.49	36.52
-117.44	36.51
-117.35	36.43
-117.32	36.43
-117.31	36.41
-117.24	36.39
-117.16	36.34
-117.09	36.30
-117.09	36.30
-117.08	36.28
-117.06	36.26
-117.06	36.23
-117.09	36.22
-117.09	36.17
-117.06	36.19
-117.04	36.17
-117.05	36.14
-117.07	36.11
-117.06	36.06
-117.01	36.06
-117.03	36.03
-117.05	36.00
-117.11	35.96
-117.10	35.92
-117.05	35.90
-117.06	35.85
-117.06	35.71
-117.00	35.68
-116.96	35.62
-116.89	35.62
-116.87	35.57
-116.91	35.54
-116.88	35.47
-116.89	35.41
-116.85	35.34
-116.81	35.24
-116.76	35.25
-116.69	35.30
-116.63	35.26
-116.51	35.30
-116.50	35.34
-116.43	35.32
-116.34	35.25

BH
8-31-94

Continued...

Brett Harden 8-31-94

Loaded new hydrography files from USGS Hydro CDROM (Ron Martin):

1. Files are packed using PKZip, unpack on PC or Ron's Amiga.
2. Copy files to /bscr0
3. Create an ARC/INFO aml to convert DLG to ARC coverages
4. Rick Klar will edit DLG coverages to remove borders.
5. Then convert to ~~rawlines~~ (ARC ungenerate)
6. Then overlay as PostScript over DEMs

dlgToAml.log Page 1

```
PERFORMER.brent: /bscr0/hydrov/benton_range [10] arc
   Copyright (C) 1989,1990,1991,1992 Environmental Systems Research Institute, I
nc.
                    All Rights Reserved Worldwide.
   ARC Version 6.1  (June 30, 1992)

   This software is provided with RESTRICTED AND LIMITED RIGHTS.  Use,
   duplication, or disclosure by the Government is subject to the
   restrictions as set forth in FAR 52.227-14 (JUN 1987) Alternate III
   (g)(3) (JUN 1987), FAR 52.227-19 (JUN 1987), or DFARS 552.227-7013
   (c)(1)(ii) (OCT 1988), as applicable.  Contractor/Manufacturer is
   Environmental Systems Research Institute, Inc. (ESRI) 380 New York St.
   Redlands, CA 92373.


Arc: &station 9999

Arc: display 9999 2


Arc: lc
    Workspace /BSCR0/HYDROV/BENTON_RANGE does not exist


Arc: ls
   Submitting command to Operating System ...
   MZ2HYF01  MZ2HYF02  MZ2HYF03  MZ2HYF04  MZ2HYF05  MZ2HYF06  MZ2HYF07  MZ2HYF0
8


Arc: w
 Current location: /BSCR0/HYDROV/BENTON_RANGE


Arc: deleteworkspace dlgs
   Deleting entire workspace:  dlgs
   Do you really want to do this  (Y/N)? y
   Deleting workspace dlgs ..

Arc: w
    Current location: /BSCR0/HYDROV/BENTON_RANGE

Arc: w ..
    WARNING: New location is not a workspace.

Arc: w
    Current location: /BSCR0/HYDROV

Arc: cw dlgs

Arc: w dlgs

Arc: ls
   Submitting command to Operating System ...
   info

Arc: dlgarc optional ../benton_range/MZ2HYF01 benton_range01
    DLG file ../benton_range/MZ2HYF01 does not exist

Arc: ls ..
   Submitting command to Operating System ...
   benton_range      duckwater         list.txt          three_rivers      wilso
n_creek_rng
   bishop            excelsior_mts     log               tonopah
   clover_mt         garrison          mt_jefferson      walker_lake
```

BK 9-1-94

Brent Hohn 9-1-94

dlgToAml.log Page 2

```
   dlgs              ione_valley       quinn_canyon_rng  warm_springs

Arc: ls ../benton_range
   Submitting command to Operating System ...
   MZ2HYF01  MZ2HYF02  MZ2HYF03  MZ2HYF04  MZ2HYF05  MZ2HYF06  MZ2HYF07  MZ2HYF0
8  log

Arc: ls ../benton_range/MZ2HYF01
   Submitting command to Operating System ...
   ../benton_range/MZ2HYF01

Arc: dlgarc optional ../benton_range/mz2hyf01 benton_range01
   Coverage name BENTON_RANGE01 is too long
   Unable to create coverage benton_range01

Arc: dlgarc optional ../benton_range/mz2hyf01 bentonr01

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.


Arc: lc
    Workspace:        /BSCR0/HYDROV/DLGS

    Available Coverages
    -------------------
     BENTONR01

Arc: arcedit
   Operating under reduced colors
   Cannot open communications to digitizer port /dev/ttyd10:9600:7bit:1.
   Copyright (C) 1989,1990,1991,1992 Environmental Systems Research Institute, I
nc.
                    All Rights Reserved Worldwide.
   ARCEDIT Version 6.1  (June 30, 1992)

   AML MESSAGE - Stopping execution of AML file due to ERROR condition
                 line 0 of file /usr/esri/arcexe61/startup/arcedit.aml

Arcedit: edit bentonr01
   The edit coverage is now /BSCR0/HYDROV/DLGS/BENTONR01
   WARNING the Map extent is not defined
   Defaulting the map extent to the BND of /BSCR0/HYDROV/DLGS/BENTONR01

Arcedit: de all

Arcedit: draw

Arcedit: ef arc
   213 element(s) for edit feature ARC
   Coverage has node attributes
   Coverage has no COGO attributes

Arcedit: select
   Point to the feature to select
   Enter point
   Arc 3 User-ID: 8 with 5 points
   1 element(s) now selected

Arcedit: delete
   1 arc(s) deleted

Arcedit: oops
   0 arc(s) deleted and 1 arc(s) restored
   Now at transaction 1
```

BK 9-1-94

Brent Hohn 9-1-94

dlgToAml.log Page 3

```
Arcedit: select
   Point to the feature to select
   Enter point
   Arc 1 User-ID: 6 with 6 points
   1 element(s) now selected

Arcedit:

Arcedit: quit
   Keep all edit changes (Y/N) : n
   Leaving ARCEDIT...

Arc: ls
   Submitting command to Operating System ...
   bentonr01     dlgtoarc.aml  info          log

Arc: &r dlgtoarc

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.

   No Area attributes in Category, PCODE file not created.

   Converting Category HYDROGRAPHY from Map BENTON RANGE, CA-NV.
   Scale is 100000, Resolution is 2.540.
```

---

dlgtoarc.aml

```
dlgarc optional ../benton_range/mz2hyf02 bentonr02
dlgarc optional ../benton_range/mz2hyf03 bentonr03
dlgarc optional ../benton_range/mz2hyf04 bentonr04
dlgarc optional ../benton_range/mz2hyf05 bentonr05
dlgarc optional ../benton_range/mz2hyf06 bentonr06
dlgarc optional ../benton_range/mz2hyf07 bentonr07
dlgarc optional ../benton_range/mz2hyf08 bentonr08
```

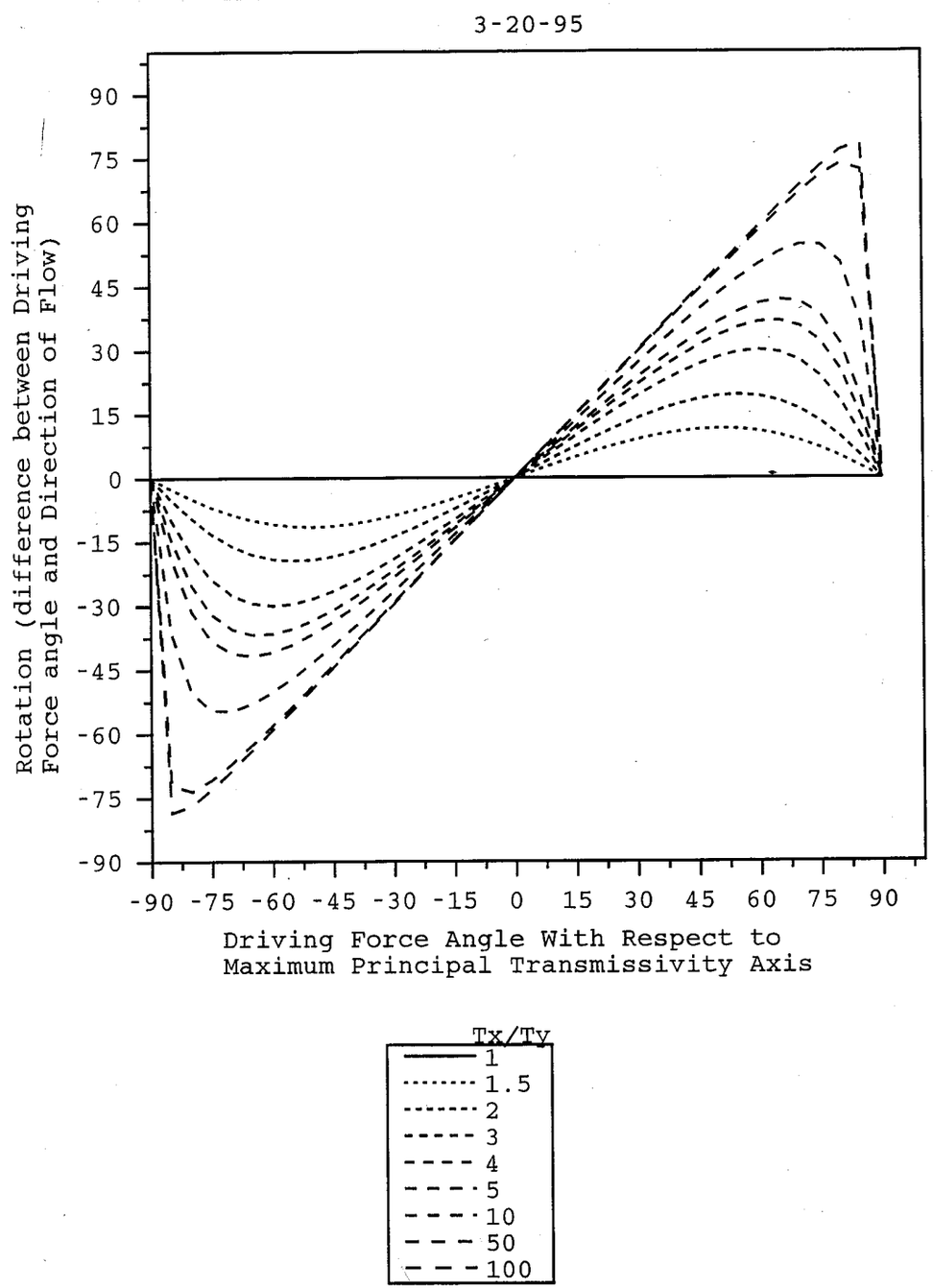
BW 9-1-94

Bert Johnson 9-1-94

Pages 1 through 10 of this Scientific Notebook were reviewed for compliance with QAP-001 in response to Corrective Action Request 94-02. Corrections and clarifications were made as appropriate. In some cases, the date of a change will reflect the date of this review rather than the date of the original Scientific Notebook entry.

Randy Folk
SwRI-QA
12/2/94

Transmissivity Plot



3-28-95

03/20/95 16:42:21

runMkData

```
#!/bin/sh -e

#-----------------------------------
# User Defined Parameters
#-----------------------------------
if [ $# -lt 1 ]
then
  echo "Usage: runMkData <tx> "
  exit
fi

MaxPTransAngle=0.0
txprin=$1
typrin=1.0

nawk 'BEGIN {
        tarad = transAngle / 57.2957795
        costa = cos(tarad)
        sinta = sin(tarad)
        printf "   DrivFAngle       Transformed      %f\n", tx

        for (dfa = -90; dfa <= 90; dfa+=5) {
           dfx = cos(dfa / 57.2957795)
           dfy = sin(dfa / 57.2957795)

           txRot = (tx * costa * costa) + (ty * sinta * sinta)
           tyRot = (tx * costa * sinta) - (ty * costa * sinta)
           qx =  txRot * dfx + tyRot * dfy

           txRot = (tx * costa * sinta) - (ty * costa * sinta)
           tyRot = (ty * costa * costa) + (tx * sinta * sinta)
           qy =  txRot * dfx + tyRot * dfy

           qAngle = atan2(qy,qx) * 57.2957795

           diffAngle = dfa-qAngle

           printf "%14.6f %14.6f %14.6f\n", dfa, qAngle, diffAngle
        }

     }' transAngle=$MaxPTransAngle tx=$txprin ty=$typrin

#          cosTheta = (dfx*qx+dfy*qy)/(sqrt(dfx*dfx+dfy*dfy)*sqrt(qx*qx+qy*qy))
#          sinTheta = sqrt(1-cosTheta*cosTheta)
#          theta = atan2(sinTheta,cosTheta)*57.2957795
```

3-28-95

03/20/95
16:42:25

runCombine

```
#!/bin/sh

runMkData   1.0  | nawk '{ print $1, $3 }' > data1.txt

for f in 1.5 2.0 3.0 4.0 5.0 10.0 50.0 100.0
do
   runMkData $f  | nawk '{ print     $3 }' > d2.txt
   cp data1.txt d1.txt
   paste d1.txt d2.txt > data1.txt
   rm d1.txt d2.txt
done

echo "Created data1.txt"
```

03/20/95
16:42:37

data1.txt

DrivFAngle 1.000000	1.500000	2.000000	3.000000	4.000000	5.000000	10.000000	50.000000	100.000000
-90.000000 0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001	0.000002
-85.000000 0.000000	-2.476372	-4.924985	-9.706481	-14.287732	-18.626652	-36.182246	-72.123386	-78.479361
-80.000000 0.000000	-4.814945	-9.425400	-17.877987	-25.195620	-31.400526	-50.441206	-73.528846	-76.754072
-75.000000 0.000000	-6.896368	-13.186785	-23.793977	-31.984754	-38.261966	-54.534170	-70.731300	-72.862684
-70.000000 0.000000	-8.632570	-16.052389	-27.515743	-35.516020	-41.211404	-54.637187	-66.854786	-68.426207
-65.000000 0.000000	-9.971307	-18.003072	-29.441464	-36.803051	-41.785440	-52.896206	-62.544081	-63.771476
-60.000000 0.000000	-10.893395	-19.106605	-30.000000	-36.586776	-40.893395	-50.173570	-58.016009	-59.007707
-55.000000 0.000000	-11.405663	-19.470355	-29.543247	-35.351555	-39.059090	-46.872275	-53.363908	-54.181787
-50.000000 0.000000	-11.532774	-19.210267	-28.334490	-33.409185	-36.593650	-43.203809	-48.634610	-49.317208
-45.000000 0.000000	-11.309932	-18.434949	-26.565051	-30.963757	-33.690068	-39.289407	-43.854237	-44.427061
-40.000000 0.000000	-10.777362	-17.239524	-24.373700	-28.152574	-30.473399	-35.203549	-39.038553	-39.519243
-35.000000 0.000000	-9.976597	-15.704657	-21.862219	-25.070870	-27.028057	-30.994644	-34.197674	-34.598817
-30.000000 0.000000	-8.948276	-13.897886	-19.106605	-21.786789	-23.413224	-26.695695	-29.338435	-29.669206
-25.000000 0.000000	-7.731005	-11.875732	-16.164880	-18.350648	-19.671920	-22.330188	-24.465666	-24.732827
-20.000000 0.000000	-6.360961	-9.685895	-13.082489	-14.800828	-15.836552	-17.915524	-19.582928	-19.791461
-15.000000 0.000000	-4.871921	-7.369260	-9.896091	-11.167636	-11.932463	-13.465131	-14.692956	-14.846477
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5.000000 0.000000	1.661961	2.495231	3.329563	3.747017	3.997556	4.498740	4.899745	4.949873
10.000000 0.000000	3.295574	4.961631	6.636273	7.475936	7.980279	8.989826	9.797945	9.898972
15.000000 0.000000	4.871921	7.369260	9.896091	11.167636	11.932463	13.465131	14.692956	14.846477
20.000000 0.000000	6.360961	9.685895	13.082489	14.800828	15.836552	17.915524	19.582928	19.791461
25.000000 0.000000	7.731005	11.875732	16.164880	18.350648	19.671920	22.330188	24.465666	24.732827
30.000000 0.000000	8.948276	13.897886	19.106605	21.786789	23.413224	26.695695	29.338435	29.669206
35.000000 0.000000	9.976597	15.704657	21.862219	25.070870	27.028057	30.994644	34.197674	34.598817
40.000000 0.000000	10.777362	17.239524	24.373700	28.152574	30.473399	35.203549	39.038553	39.519243
45.000000 0.000000	11.309932	18.434949	26.565051	30.963757	33.690068	39.289407	43.854237	44.427061
50.000000 0.000000	11.532774	19.210267	28.334490	33.409185	36.593650	43.203809	48.634610	49.317208
55.000000 0.000000	11.405663	19.470355	29.543247	35.351555	39.059090	46.872275	53.363908	54.181787
60.000000 0.000000	10.893395	19.106605	30.000000	36.586776	40.893395	50.173570	58.016009	59.007707
65.000000 0.000000	9.971307	18.003072	29.441464	36.803051	41.785440	52.896206	62.544081	63.771476
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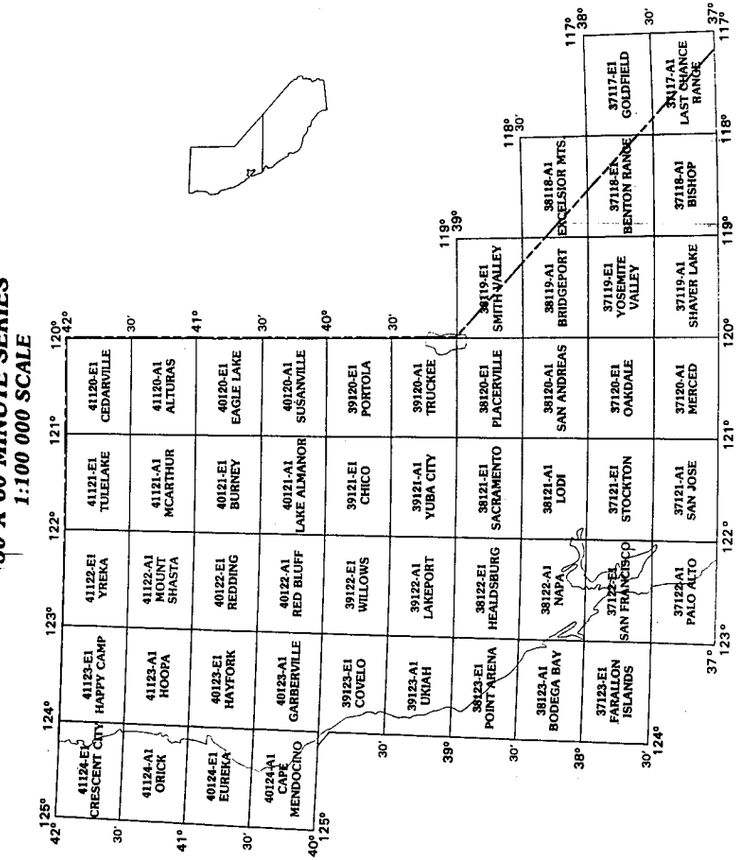
Bruce Hahn 3-28-95

Maps order:

CALIFORNIA
NORTH HALF

33

30 X 60 MINUTE SERIES
1:100 000 SCALE



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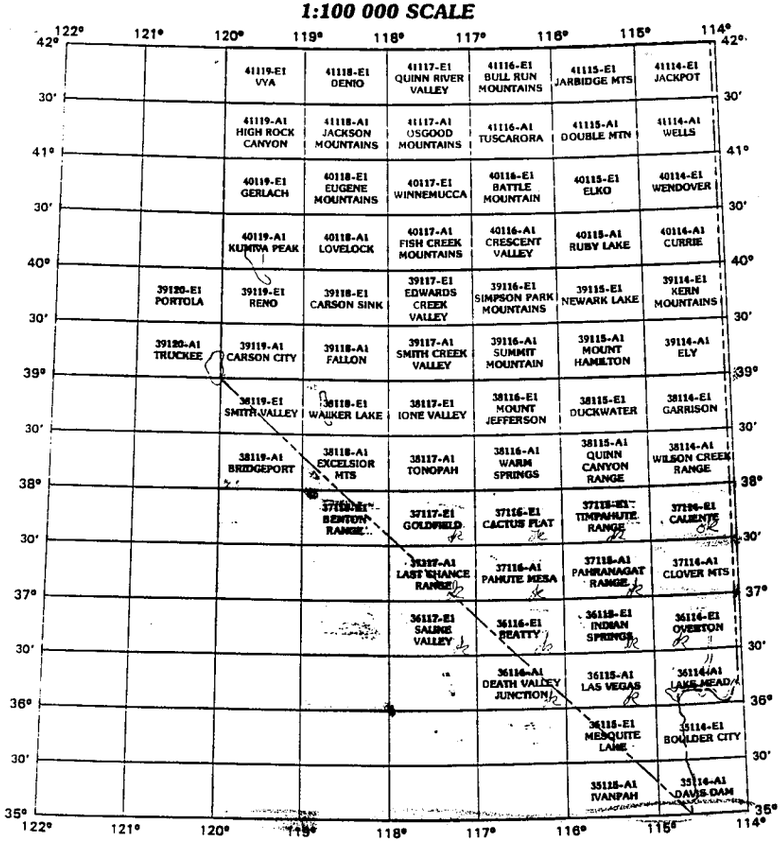
Bruce Hahn
12-20-95

Maps:

30 X 60 MINUTE SERIES
1:100 000 SCALE



1:100,000-scale maps are planned for the entire State

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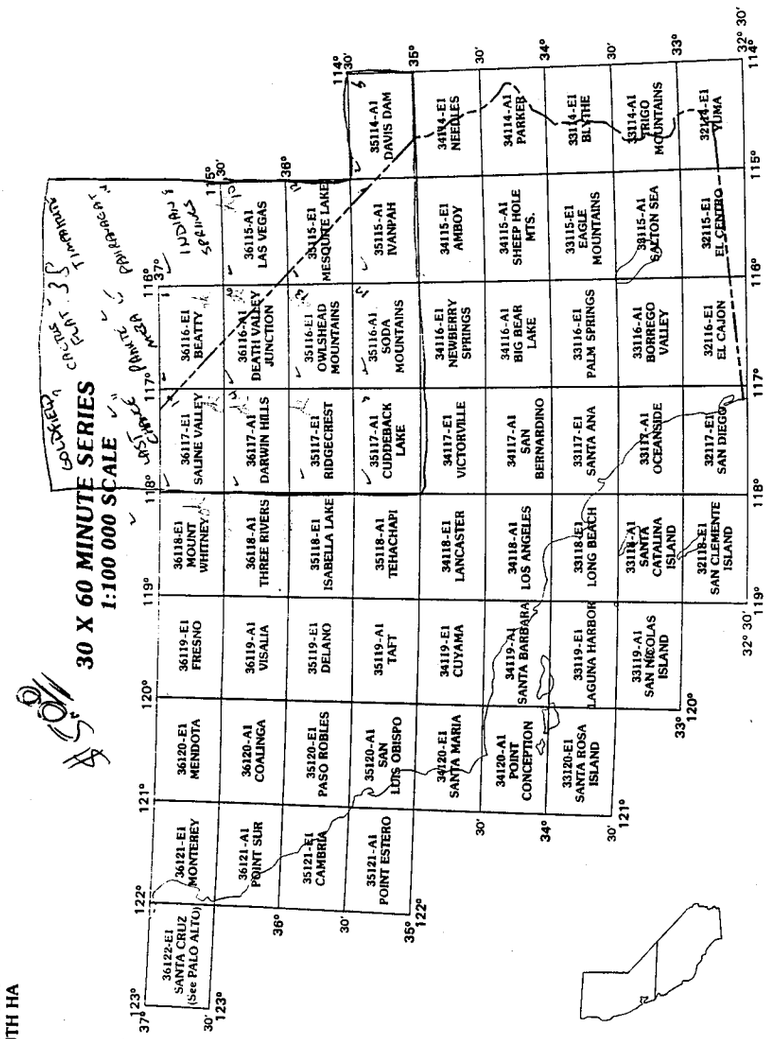
12-20-98

Maps:



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CALIFORNI
SOUTH HA

70

12-20-95

Porosity model:

Table 1. Computed input variables for porosity (arithmetic means) and k_{sat} (geometric means) for the hydrostratigraphic models. Welded units are indicated by "w", and non-welded units by "n".

Lithostratigraphic Unit (Symbol) [Youngest to oldest from top of list]	matrix porosity	matrix k_{sat} (m/sec)
Tiva Canyon (Tpcw)	0.15	1.5E-10
Undifferentiated Upper Paintbrush (n3-PTn)	0.42-0.45	1.7E-07
Lithophysae-rich Topopah Spring (Tptw-TSw1)	0.16	2.4E-10
Lithophysae-poor Topopah Spring (TSw2+3)	0.14	8.5E-11
Calico Hills (CHn1..3-n2)	0.30	4.8E-10
Prow Pass (PPw)	0.26	1.4E-10
Upper Crater Flat (CFUn)	0.29	5.1E-10
Bullfrog (BFw)	0.21	1.1E-09

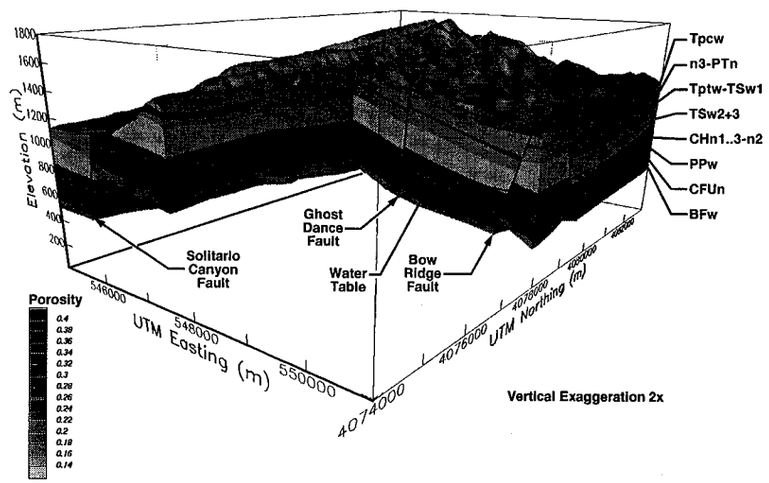


Figure 1. Perspective view of the CNWRA 3D porosity hydrostratigraphic model. Layering corresponds to the eight lithostratigraphic units comprising the 3D geological framework model.

Pat Hahn
12-20-95

Estimating uncertainty of subsurface lithology:

This is after discussing w/ David — Pat 11/Am

Estimating Uncertainty of 3D Model Subsurface Lithology

Below are the steps and manhour estimates required to estimate uncertainty of 3D model for a single horizon in a single fault block.

Step	Description	David Hrs Est	Brent Hrs Est	Ross Hrs Est	Gerry Hrs Est
1	Compute errors of current 3D model subsurface horizon top vs. 17 boreholes	8	0	0	0
2	Interpolate errors from step 1 over entire map range using kriging	16	16	0	0
3	Develop methods for extracting and comparing 3D model surface outcrop of unit top vs. digitized geological map surface outcrop data	16	24	0	0
4	Incrementally adjust 3D model subsurface horizon top in order to minimize surface outcrop of 3D model and digitized geological map	24	16	0	0
5	For each increment in step 4, compute errors of 3D model subsurface horizon top vs. 14 boreholes	8	0	0	0
6	For each increment in step 5, interpolate errors using kriging	8	0	0	0
7	Plot maps from step 6 in order to determine whether minimizing differences of 3D model surface outcrops and digitized geological map decreases errors of 3D model subsurface unit tops and borehole lithologies	16	0	0	0
	Totals	96	56	0	0

12/19/95

UNCERT.XLS

Pat Hahn
12-20-95

FAX to DGI on est. uncertainty:

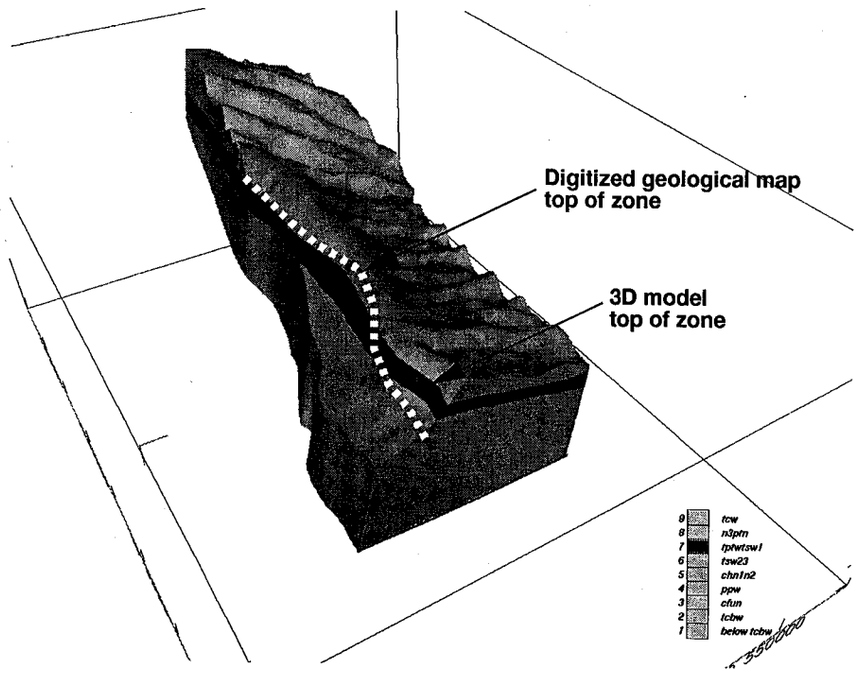
December 19, 1995

TO: Karen Hoffman, DGI, fax 713-952-1832

FROM: Brent Henderson, SwRI-CNWRA, 210-522-5155 fax

SUBJECT: Comparing surface outcrop data

Ross is interested in refining our subsurface horizons based on surface geology maps.



Brent Henderson
12-20-95

FAX continued:

In order to do this we need to:

(1) Compute difference between top of zone in 3D model and geological map at the surface outcrops

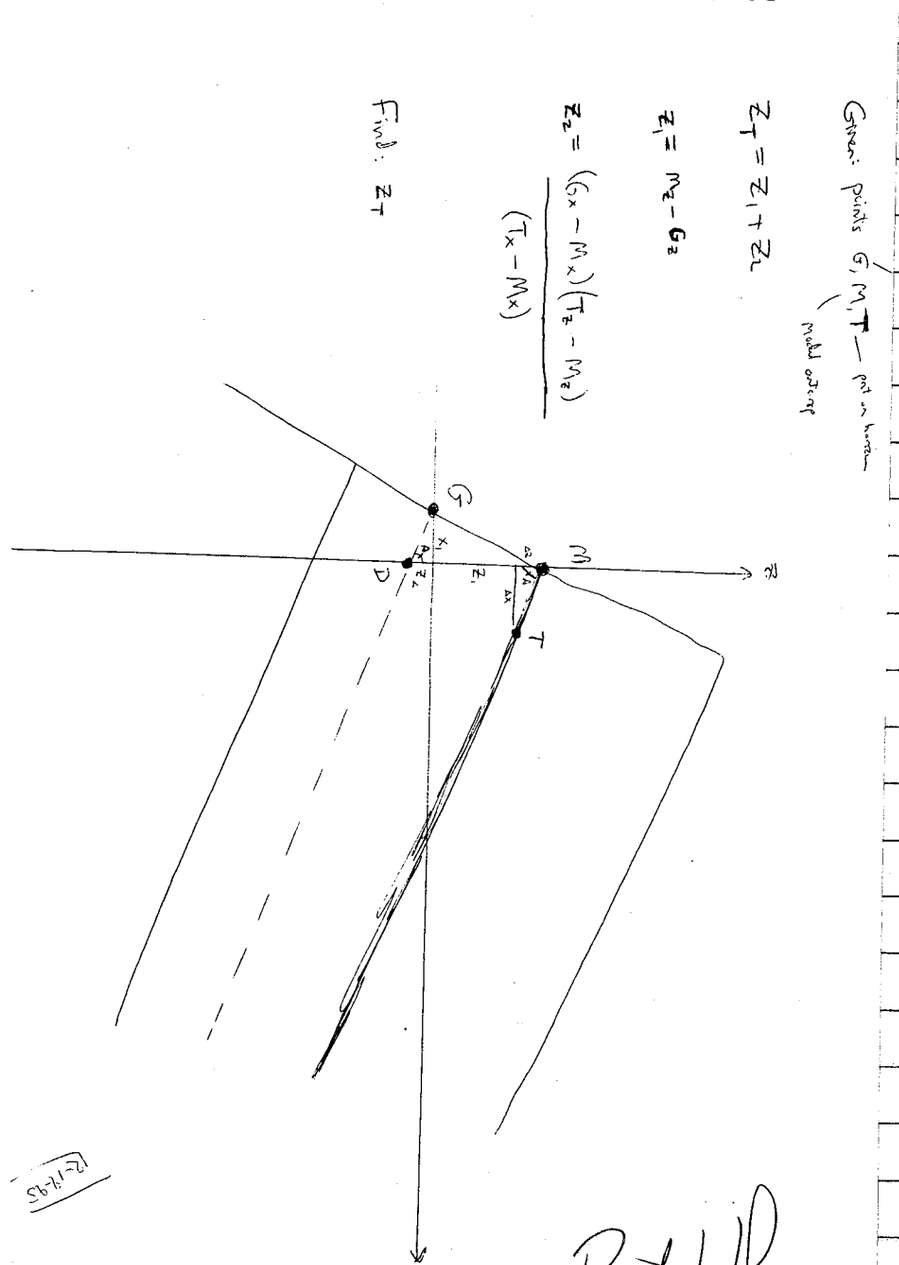
I'm thinking of doing this by extracting the surface outcrop polygons from the 3D model and comparing them to digitized lines from geological maps.

(2) Adjust horizon up/down according to differences computed in step (1). As you can see in the fake example on the previous page, horizon grids may have to be raised up in some places and lowered down in other places.

Any suggestions off the top of your head on doing the above steps?

Brent Henderson
12-20-95

Method for computing depth difference of horizon in 3D model at surface outcrop polygon.



Brent Henderson
12-20-95

This research project was formally closed on January 19, 1996. This scientific notebook describes work conducted by Brent Henderson on behalf of the project to prepare maps and diagrams, and conduct quantitative analyses about the relationship of the Death Valley flow system and the regional geology and structure. Many of the results described in the notebook are also summarized in the CNWRA semi-annual research reports.

Gordon Wittmeyer

Principal Investigator

2/5/96