

Seismicity Maps for
“Chroma Depth 3D Glasses”
using
“The Generic Mapping Tools”

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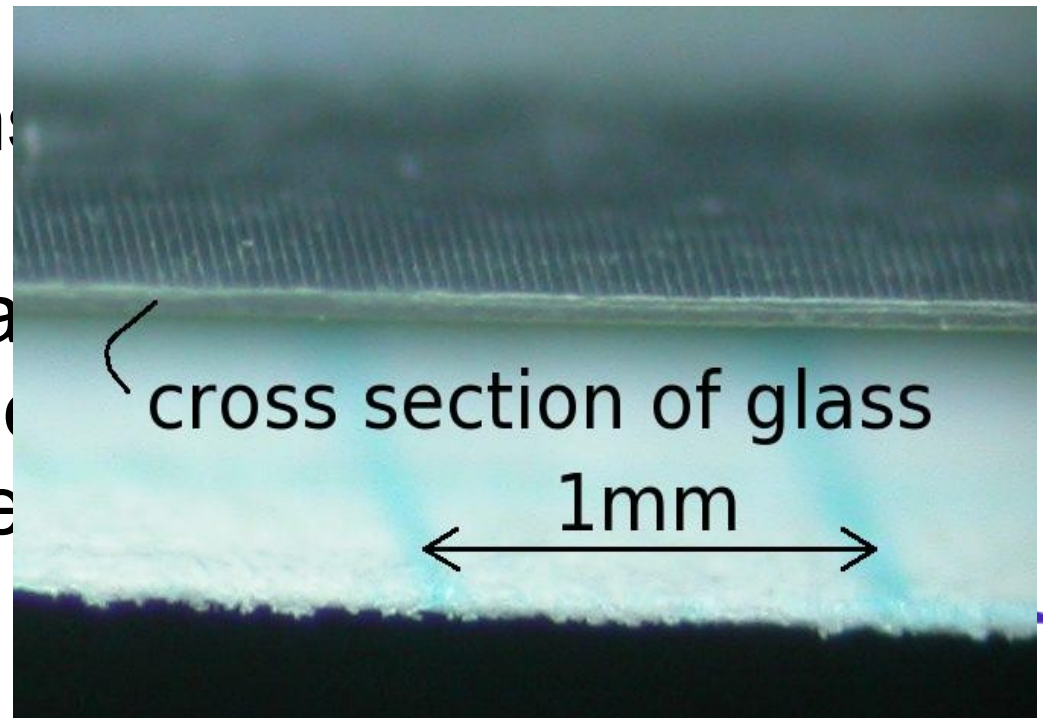
1. Chromostereoscopy

- In geology or geomorphology, 3D visions are mainly developed using stereo-photos, blue-red anaglyph or polarized glasses.
- In contrast, “Chroma Depth 3D Glasses™” make 3D world only using rainbow coloured chart in a black background; **red** is for shallower, **blue** is for deeper, **yellow** to **green** for middle ones.
- Their simple mechanism and amazing effects are surprising and also quite interesting.
- Also the glasses cost 1 US Dollar only!
- Seeing is believing -----> Please look at the maps through the hanging glasses!!



2. Mechanism, --How it works?

- Chroma Depth 3D Glasses™ simply convert rainbow colours to the depth perception on both printed and electrical displayed charts.
- The detail of mechanism is not obvious in their web site or US-patent reports.
- At first, we thought it as two “thin micro-prisms” once our abstract however the refraction sense is reversed we expected
- Glass cutting! brought no answer. → see photo



3. Mechanism, How it works?(Part 2)

- Until now, the most plausible explanation of the glasses is found in the “Christian Ucke's(1998)” paper (see references).
 - Please guess the mechanism of glasses by taking them! ----->
- (Ucke's solution is in the next page →)



Christian Ucke's idea :from "3-D Vision with ChromaDepth Glasses, 1998"

- --Not "Micro-prisms(Fig.2)"
- --But "Blazed gratings(Fig3,4)"

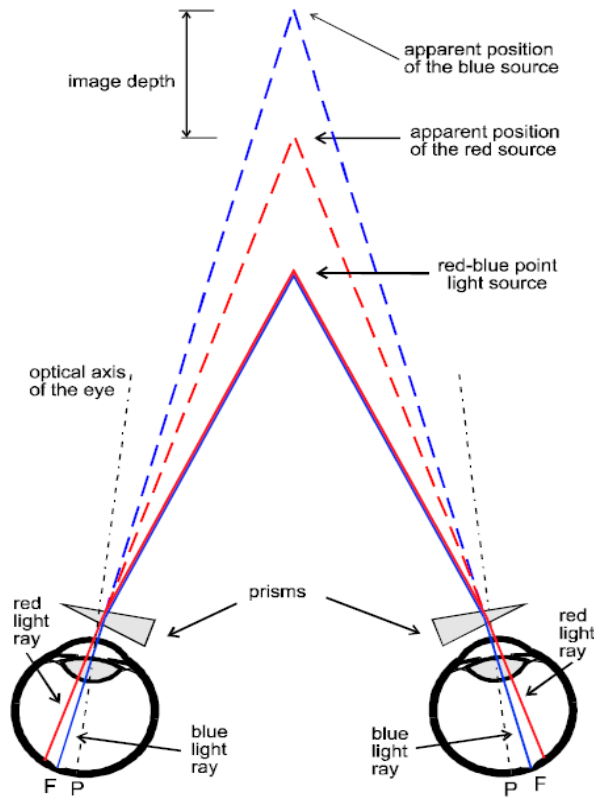


Fig. 2: Here are positioned prisms in front of each eye. Due to the dispersion in the prisms the angle between the blue and the red ray in the eye is bigger.

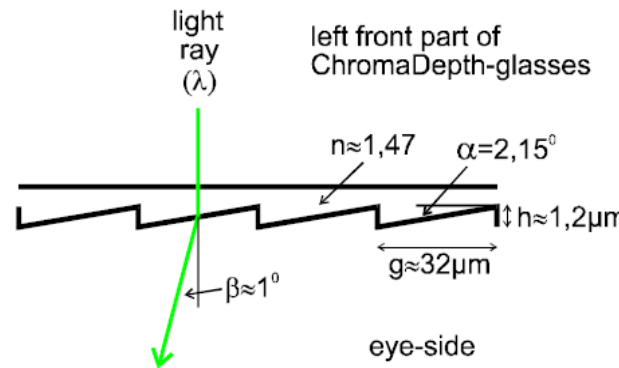


Fig. 3: A cross-section through the left part of ChromaDepth glasses.

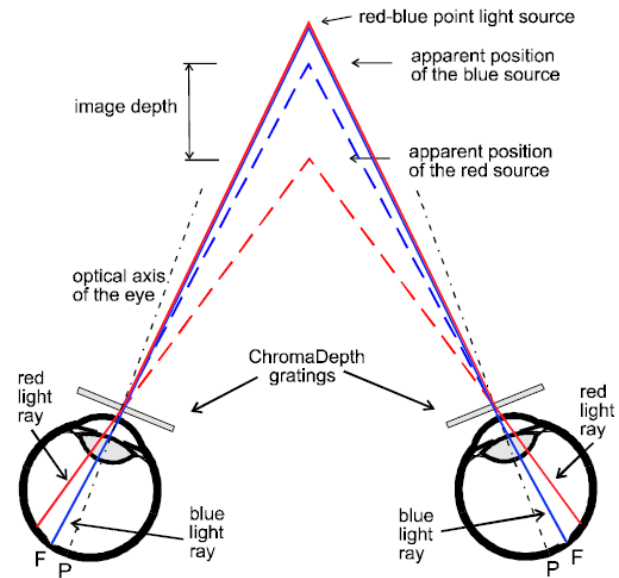


Fig. 4: Chromostereoscopy with ChromaDepth glasses



4.Data and scripts

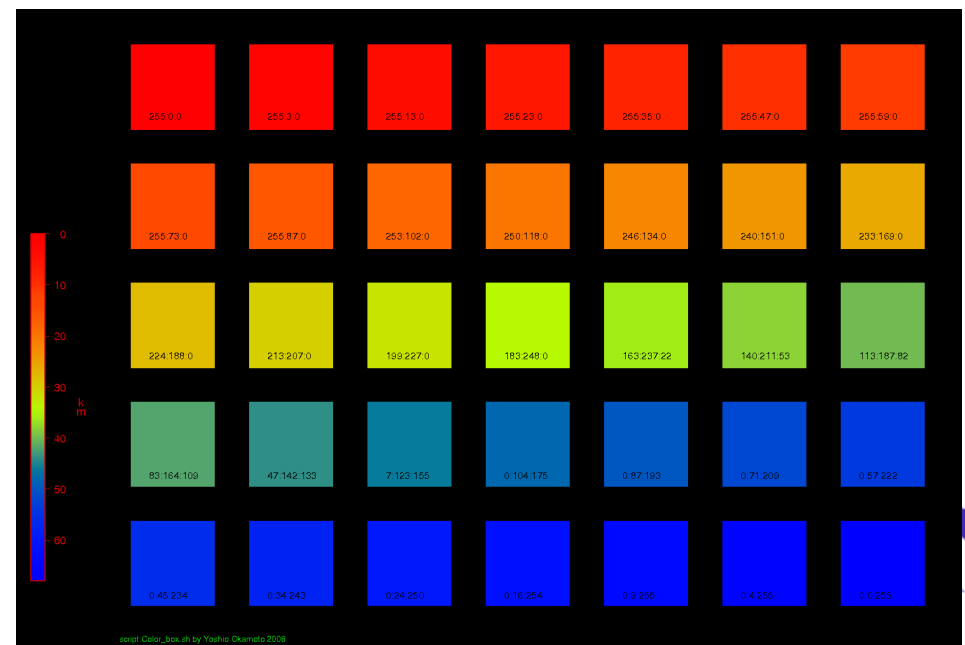
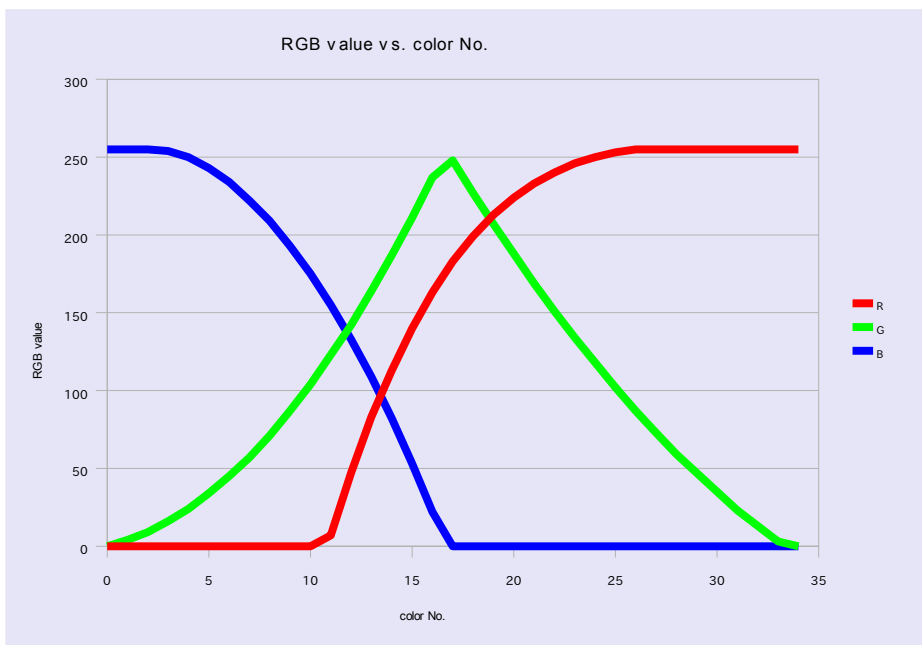
- A prototype of 3D seismicity maps were developed on a limited type PC (Okamoto, 1998), as the first application of chromostereoscopy to seismology.
- This year, the data and procedures are renewed and improved for various platforms operating on Unix or even on MS-Windows.
- “*The Generic Mapping Tools (Wessel and Smith, 1988)*” are used for map producing.
- Seismicity data, compiled by JMA for Japan and by USGS for world wide are used respectively.
- Before plotting, epi-focus data are sorted by depth to avoid colour contamination.



5. Colour code

- Colour code is most important in our method.
- After some trials, we slightly modified the RGB values on ChromaDepth web site and made our own 35-colour pallets for plotting earthquakes.

#col	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
R	0	0	0	0	0	0	0	0	0	0	0	7	47	83	113	140	163	183	199	213	224	233	240	246	250	253	255	255	255
G	0	4	9	16	24	34	45	57	71	87	104	123	142	164	187	211	237	248	227	207	188	169	151	134	118	102	87	73	59
B	255	255	255	254	250	243	234	222	209	193	175	155	133	109	82	53	22	0	0	0	0	0	0	0	0	0	0	0	0



6. Map examples

- We developed the following regional maps.
- Subducting plate zones: Each part of Japan, Philippines, Indonesia, Alaska, Mts. Andes, Caribbean sea etc.
- Active fault zones or volcanic zones: California, Western China, Kobe earthquake area, Tyuetsu eq. area, Miyake-jima, Hawaii Is. etc.
- The depth scale and projection method are varied for each map applying suitable parameters.
- Example charts (Epson ink-jet printer + Photo paper) are on the right hand and a GMT script is in the next page--->.



7.A script example

```
#!/bin/bash
# [Hawaii_c_ANSSsh]*****
# GMTで世界のChromaDepth震源マップを書くスクリプト
# data from ANSS 1995-2008_June M0=<
# http://www.ncedc.org/anss/catalog-search.html
# Date      Time      Lat      Lon Depth  Mag Magt Nst Gap Clo RMS SRC Event ID
# -----
# 2002/01/01 00:37:03.35 19.3010 -65.0350 25.00 3.70 Mc 8 0.00 RSP 200201014001
# 34-color mode
# by Y.Okamoto 22/July 2008
# *****
export PATH=$PATH:/usr/lib/gmt/bin
seis_file="Hawaii_ds.dat"
out_file="Hawaii_c_ANSS.ps"
cpt_file="68_cpt.csv"
Pen_w=4 # pen width
Area=-156.4/-154.8/18.7/20.0 # Draw area
scale=24 # width
M=0.002

echo "0 0 24 0 0 6 Hawaii Seismicity Map (data from ANSS 1995-2008)" > title.txt
echo "0 0 10 0 0 6 script:Hawaii_c_ANSS.sh by Yoshio Okamoto 2008" > credit.txt
#col 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 (line color)
R=( 0 0 0 0 0 0 0 0 0 0 0 0 7 47 83 113 140 163 183 199 213 224 233 240 246 250 253 255 255 255 255 255 255 255)
G=( 0 4 9 16 24 34 45 57 71 87 104 123 142 164 187 211 237 248 227 207 188 169 151 134 118 102 87 73 59 47 35 23 13 3 0)
B=(255 255 255 254 250 243 234 222 209 193 175 155 133 109 82 53 22 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)

D_max=68
D_min=0
# int(68/34)
D_inc=2
i=0

pscoast -R$Area -JM$scale -Df -G0 -S0 -B1g1 -W$Pen_w/220/0/0 -K> $out_file

awk '{if ($3 >= $D_max+100) { print $1,$2,$4*$M }}' $seis_file | psxy -J -R -V -O -K -Sc -L -W$Pen_w/0/60 -P -N>> $out_file
awk '{if ($3 >= $D_max+50 && $3 < $D_max+100) { print $1,$2,$4*$M }}' $seis_file | psxy -J -R -V -O -K -Sc -L -W$Pen_w/0/120 -P -N>> $out_file
awk '{if ($3 >= $D_max && $3 < $D_max+50) { print $1,$2,$4*$M }}' $seis_file | psxy -J -R -V -O -K -Sc -L -W$Pen_w/0/180 -P -N>> $out_file
let DD=$D_max
let D=$D_max-$D_inc

while [ $i -le 34 ]; do
echo The color counter is $i
echo The RGB values are ${R[$i]} ${G[$i]} ${B[$i]}
echo The Depth Range is $D km to $DD km
awk '{ if (($3 >= $D) && ($3 < $DD)) { print $1,$2,$4*0.002}}' $seis_file | psxy -J -R -V -O -K -Sc -L -W$Pen_w/${R[$i]}/${G[$i]}/${B[$i]} -P -N>> $out_file
let i=i+1
let D=D-$D_inc
let DD=DD-$D_inc
done

pscoast -R -J -Df -lr -N1/2 -B -U -W4/255/0/0 -O -K>> $out_file

# -R0/6/0/4:dummy
awk '{ print $1,$2,$3,$4,$5,$6,$7}' mag1.txt | pstext -Jx1.0c -R0/6/0/1 -D0/0.3 -O -K -G0/220/0 -N>> $out_file
awk '{ print $1,$2+0.16,$2*4*0.002}' mag1.txt | psxy -Jx1.0c -R -D1/0.3 -O -K -Sc -L -W4/0/220/0 -N>> $out_file

# scale x / y /length/width
psscale -C$cpt_file -D-0.7/6.0/9.8/0.12 -B10:km: -K -O >> $out_file
pstext title.txt -Jx1.0c -R -D12/21.0 -G0/220/0 -N -O -K>> $out_file
pstext credit.txt -Jx1.0c -R -D2.9/-0.65 -G0/220/0 -N -O >> $out_file
```



8. Discussions

- Advantages--> Subducting plate profiles (so called “Wadati-Benioff zones”) are clearly recognized, therefore this has brought us clear sub surface images of plates collision like a transparent 3D model.
- Disadvantages--> Complicated seismic profiles such as active fault zones or volcanic activities are not so clearly displayed because of the colour pixel dividing particularly in orange colour; red and green.
- Nevertheless some back draws, this 3D effect is strikingly amazing, therefore for educational or outreach purposes are strongly recommended.
- Also, the 3D mechanism of these glasses itself is just a suitable educational tool for optics study at all levels.



9.To the Future

- Doubling of pixel and ink colours within **yellow** to **orange** considerably spoils the map perception. --> a major flaw of this method.
- The map quality strongly depends on the depth accuracy of focal data. -> The JMA inland data have enough accuracy while the world data do not.
- Present maps have shorelines only, no topo profiles both land and sea area, so the 3D topo construction above quakes are desirable.
- Above purpose, We have an intention to use 3D free rendering tools such as “Povray”.



10. Acknowledgements and References

- **<Acknowledgements>** I would like to express my gratitude to Prof. Christian Ucke for providing me with some useful advice and permitting the quotation of his article. Also the constructive comment from Dr. Henning Lorenz was profitable to improve my article.
- **<References>**
- Yoshio Okamoto: 3D Visualization of Seismicity Maps with ChromaDepth 3D Glasses, abstract for 1998 Japan Earth and Planetary science Joint Meeting.
- Christian Ucke: "3-D Vision with ChromaDepth Glasses" published in the proceedings of the ICPE/GIREP-conference 'Hands-On Experiments in Physics Education' August 23 - 28, 1998 in Duisburg/Germany, University of Duisburg 1999, page 371-374
- Chromatek Inc.: <http://www.chromatek.com/howto.htm>
- **How to get the glasses:** <http://www.the3dmarket.com/Paper/chromadepth.asp>
- **All scripts of this article** are now available through our web site as public domains. <http://www.osaka-kyoiku.ac.jp/~yossi/>

