The History of Seismic Interpretation Workstations

H. Roice Nelson, Jr.

DHI Consortium Meeting

22 September 2016

Definitions:

- The: Roice Nelson's version of what happened.
- History: Potential content for a book I would like to write.
- Of: The focus of the planned book.
- Seismic: Includes potential fields and other geophysics.
- Interpretation: Interactive Workstation Interpretation.
- Workstations: Tools to accomplish Interactive Interpretation.
- Interactive: Finding an answer before you forget the question.

Disclaimer: selected stories only give snapshots of the history,
this presentation is not in any way a complete history.

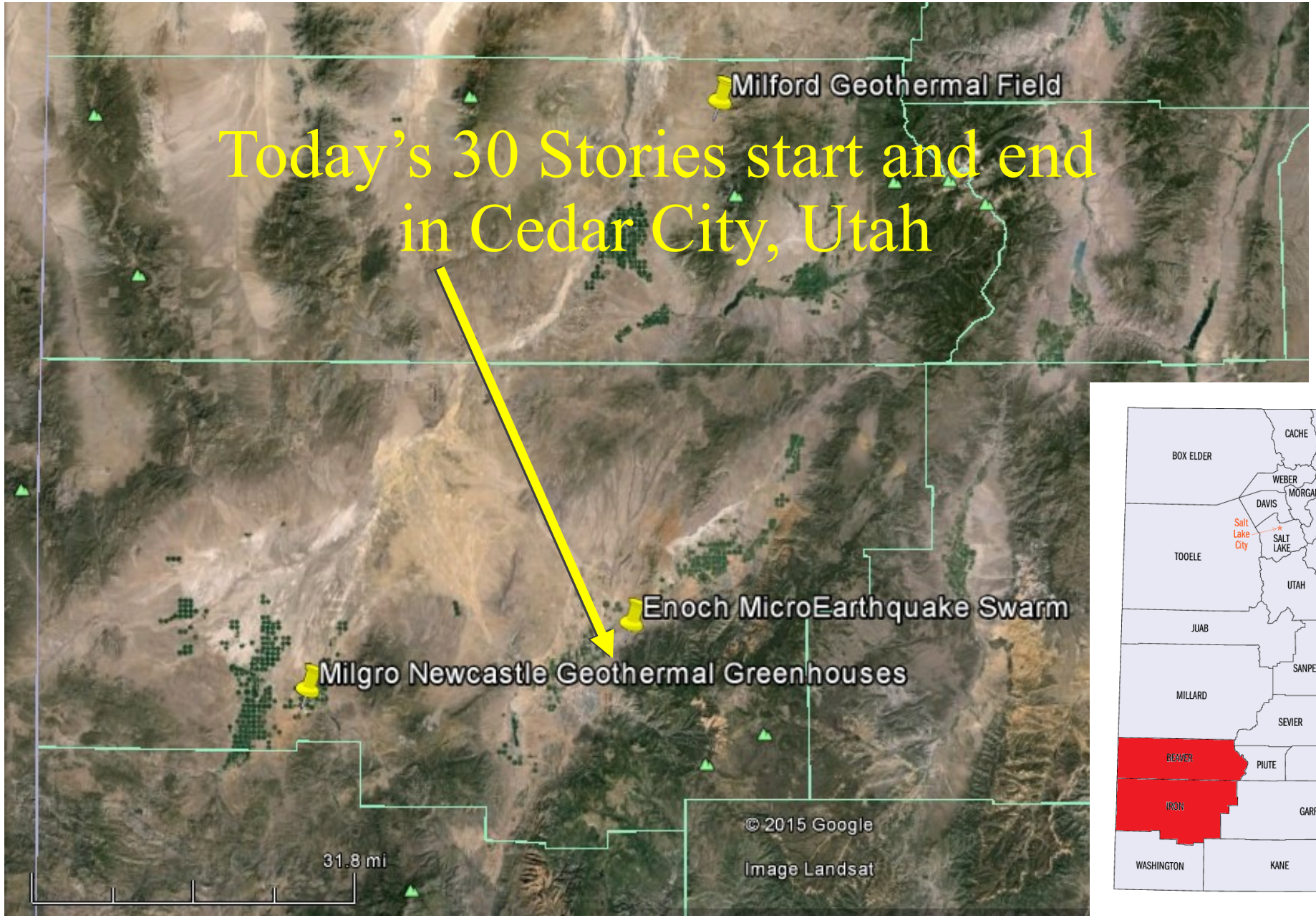
Success Has Many Parents

The first 90 names that came to mind.
Please remind me of others!

- Howard and Pauling Nelson
  taught me to work and think
- Grandpa Paul Adolf Hafen
  taught me to pursue dreams
- Grandpa Roice Bengt Nelson
  died before birth, legacy of work
- New Mexico State University
  JESSIE – 1967 summer sciences
- Oregon State University 1968 NSF
  summer science in earth sciences
- Robert (Bob) Otis, Big Brother in
  Fraternity , Pan Am Scholarship,
  and first 3-D display from thesis
- Ivan Sutherland
  Computer Science Professor U of U
- Dr. Ralph Shuey
  First Geophysics Advisor U of U
- Dr. Barbara (formerly Bill) Nash
  Mineralogy Professor U of U
- Dr. Ken Cook
  Potential Fields Professor U of U
- Dr. Stanley Ward
  Department Chair Geophysics UofU
- Dr. Robert S. Smith
  Second Geophysics Advisor U of U
- S. Parker Gay, Jr.
  Applied Geophysics, job 3D maps
- Riley Skeen
  Roommate Denver & U of U
- Bob Kalwaitt
  Pan Am & Amoco Manager
- Alex Benton
  Pan Am & Amoco Manager
- Craig Hanson
  Pan Am & Amoco Manager
- Pan American (1969-1970, Sun Oil
  (1973) & SEG (1974) Scholarships
- Dale Boren
  Recruiter Mobil Oil
- Bill Ayres
  Human Relations Mobil Oil
- Robert (Bob) Peacock
  Manager Mobil Oil told me to
  pursue dream even if left Mobil
- Martha Sharp Nelson
  Wife 1974-1996
- Will Gray
  Researcher at Mobil Research
- Tom Hearst
  Researcher at Mobil Research
- Bill Ruhle
  Technology Manager Mobil Oil
- Townsend Dunn
  Co-Worker Mobil Oil
- Ron Krinsky
  Co-Worker Mobil Oil
- John Potosky
  Co-Worker Mobil Oil
- Mike Burnaman
  Co-Worker Mobil Oil
- Jim Bedford
  Co-Worker Mobil Oil
- Harold J. Kidder
  Manager Mobil Training SEG Pres.
- Jack Peffer
  Manager Mobil International
- Graves Noble
  Manager Mobil International
- Clem Novasad
  Geologist Mobil International
- Byron Arnason
  Mobil Field Operations
- Arnold Engstrom
  Manager Mobil Special Exploration
  Projects, to Senegal & West Africa
- Courtenay Gans
  Manager Mobil International
- Charlie Menard
  Manager Mobil New Orleans
- Terry Godsey
  Manager Mobil Field Operations
- Bob Heinman
  Manager Mobil Field Operations
- Ed Gray U of U, Mobil,
  Computer Genealogical Services
- Richard Holtry
  Computer Genealogical Services
- Dave Evans
  President Evans & Sutherland
- Steve Johnson
  Medical Computer Science U of U
- Vel Cessler
  Manager Evans & Sutherland
- Wayne Wade
  Salesman Evans & Sutherland
- David Nebeker
  Programmer Evans & Sutherland
- Jack Winkle
  Mobil Oil Houston
- Steve Chatterley
  Manager Evans & Sutherland
- Paul Sovelious
  Evans & Sutherland
- Dr. Fred J. Hilterman
  Founder Seismic Acoustic Lab
  U of U, hired me from Mobil Oil
- Dr. Keith Wang
  PI Seismic Acoustics Lab
- Dr. Gerry Gardner
  New PI Seismic Acoustics Lab
- Dr. John McDonald
  New PI Seismic Acoustics Lab
- Barbara Murray
  Admin Seismic Acoustics Lab
- Julie Norris
  Administrator U of H
- Dr. Richard Verm
  Student Seismic Acoustics Lab
- Dr. Tom Morgan
  Student Seismic Acoustics Lab
- Dr. Edip Baysal
  Student Seismic Acoustics Lab
- Dr. Bill French
  Sponsor Seismic Acoustics Lab
- Dr. Walt Turpening
  Sponsor Seismic Acoustics Lab
- Dr. Dick Kostolnechek
  Exxon Rep & SAL User Group
- Steve Ruhl
  U of H Electrical Engineer Support
- Bob Hirsch
  Superior Oil VP & Keck Foundation
- Dr. Anne (formerly Steve) Simpson
  Director Image Processing Lab
- Dr. Tom Smith
  Student Seismic Acoustics Lab
  Founder Seismic Micro Technology
- Dr. Bob Sheriff
  Geophysics Professor U of H
- Dr. John Butler
  Geology Professor U of H
- Dr. Dan Kosloff
  University of Tel Aviv Professor
- Dr. David Kessler
  University of Tel Aviv Student
- Greg Schmitlein
  Manager Control Data Corporation
- Mickey Edwards
  Programmer CDC
- Tom Eliseuson
  Manager CDC
- Deepak Khosla
  Student Seismic Acoustics Lab
- Thomas N. Gardner
  Sales Representative Adage
- Dr. Wulf Massell
  Director Research Geosource
- Don Winningham
  Developer Geosource
- Dr. Bob Tatham
  Researcher Geosource
- John Sudaym
  SAL Representative UPC
- Phillippee Zaccanino
  SAL Representative Elf Aquitaine
- Bob Limbaugh
  Manager Digicon and hired as
  Employee #1 at Landmark Graphics
- Lars Sonneland
  Researcher GECO
- Marion Bone
  SAL Representative GSI
- Laura Pankonien
  Editor Gulf Publishing
- Dave Peters
  SAL Representative Chevron
- Terry Smith
  Developer Digicon, Employee #5
- John Dolman
  SAL Representative ICI Petroleum
- David Jenkinson
  SAL Representative Tenneco
- John Farr
  SAL Representative Western Geo
- Gary Lindquist
  Marketing Director Sierra Geop

I take responsibility for omissions, deletions, misspellings, unintended misrepresentations, etc.

Today's 30 Stories start and end in Cedar City, Utah



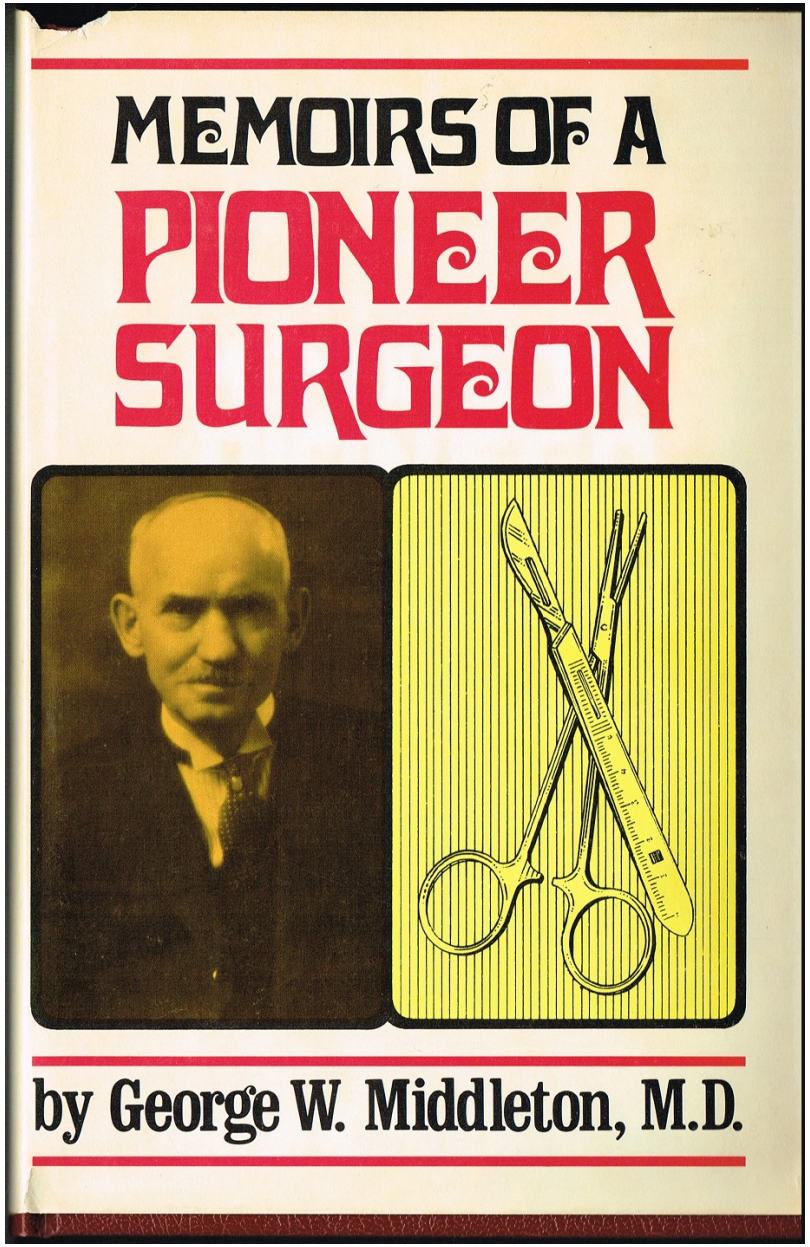
I grew up on the back end of a shovel …

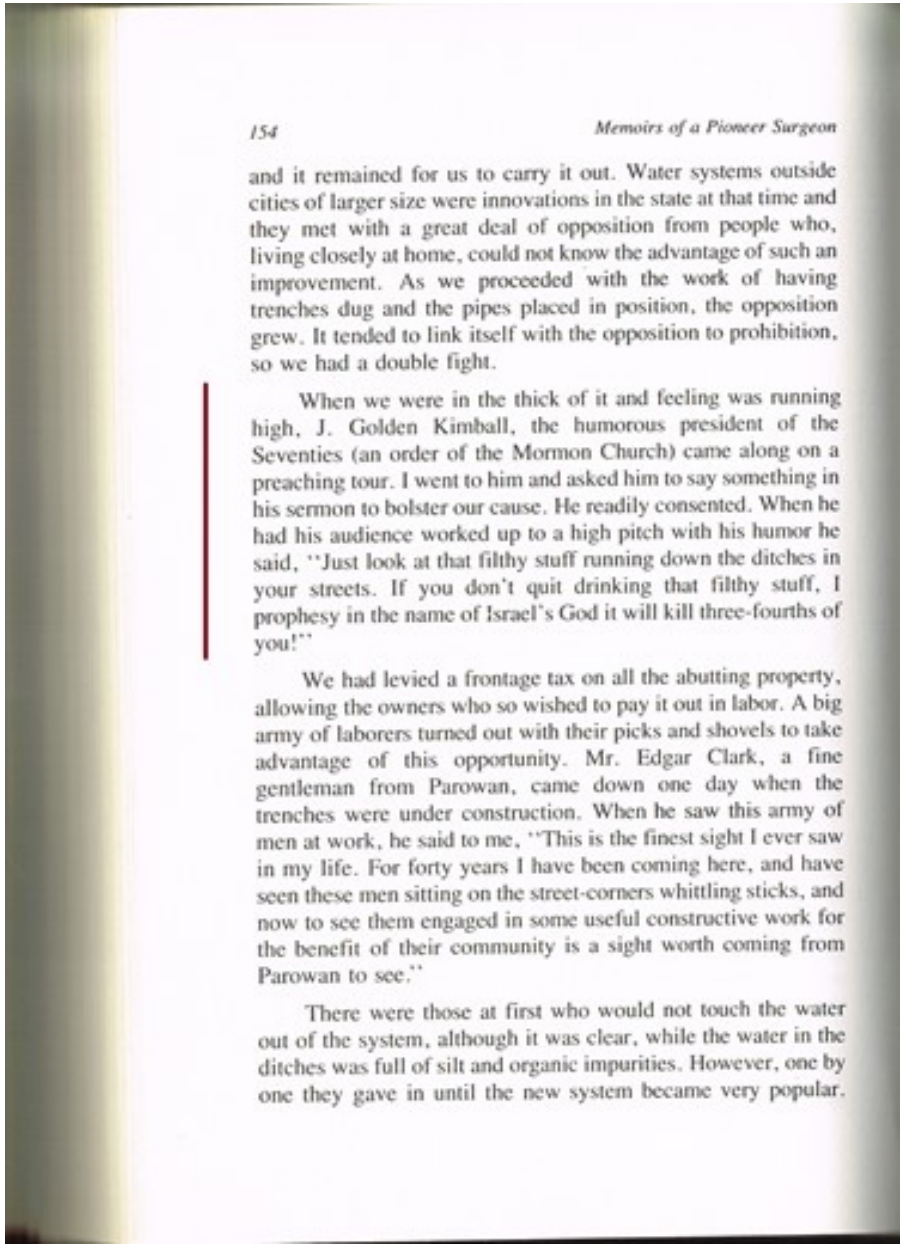
… to boldly go …

Before 1980

1. My first story occurred in 1903.

It is regarding water issues in Cedar City, Utah.





154 *Memoirs of a Pioneer Surgeon*

and it remained for us to carry it out. Water systems outside cities of larger size were innovations in the state at that time and they met with a great deal of opposition from people who, living closely at home, could not know the advantage of such an improvement. As we proceeded with the work of having trenches dug and the pipes placed in position, the opposition grew. It tended to link itself with the opposition to prohibition, so we had a double fight.

When we were in the thick of it and feeling was running high, J. Golden Kimball, the humorous president of the Seventies (an order of the Mormon Church) came along on a preaching tour. I went to him and asked him to say something in his sermon to bolster our cause. He readily consented. When he had his audience worked up to a high pitch with his humor he said, "Just look at that filthy stuff running down the ditches in your streets. If you don't quit drinking that filthy stuff, I prophesy in the name of Israel's God it will kill three-fourths of you!"

We had levied a frontage tax on all the abutting property, allowing the owners who so wished to pay it out in labor. A big army of laborers turned out with their picks and shovels to take advantage of this opportunity. Mr. Edgar Clark, a fine gentleman from Parowan, came down one day when the trenches were under construction. When he saw this army of men at work, he said to me, "This is the finest sight I ever saw in my life. For forty years I have been coming here, and have seen these men sitting on the street-corners whittling sticks, and now to see them engaged in some useful constructive work for the benefit of their community is a sight worth coming from Parowan to see."

There were those at first who would not touch the water out of the system, although it was clear, while the water in the ditches was full of silt and organic impurities. However, one by one they gave in until the new system became very popular.

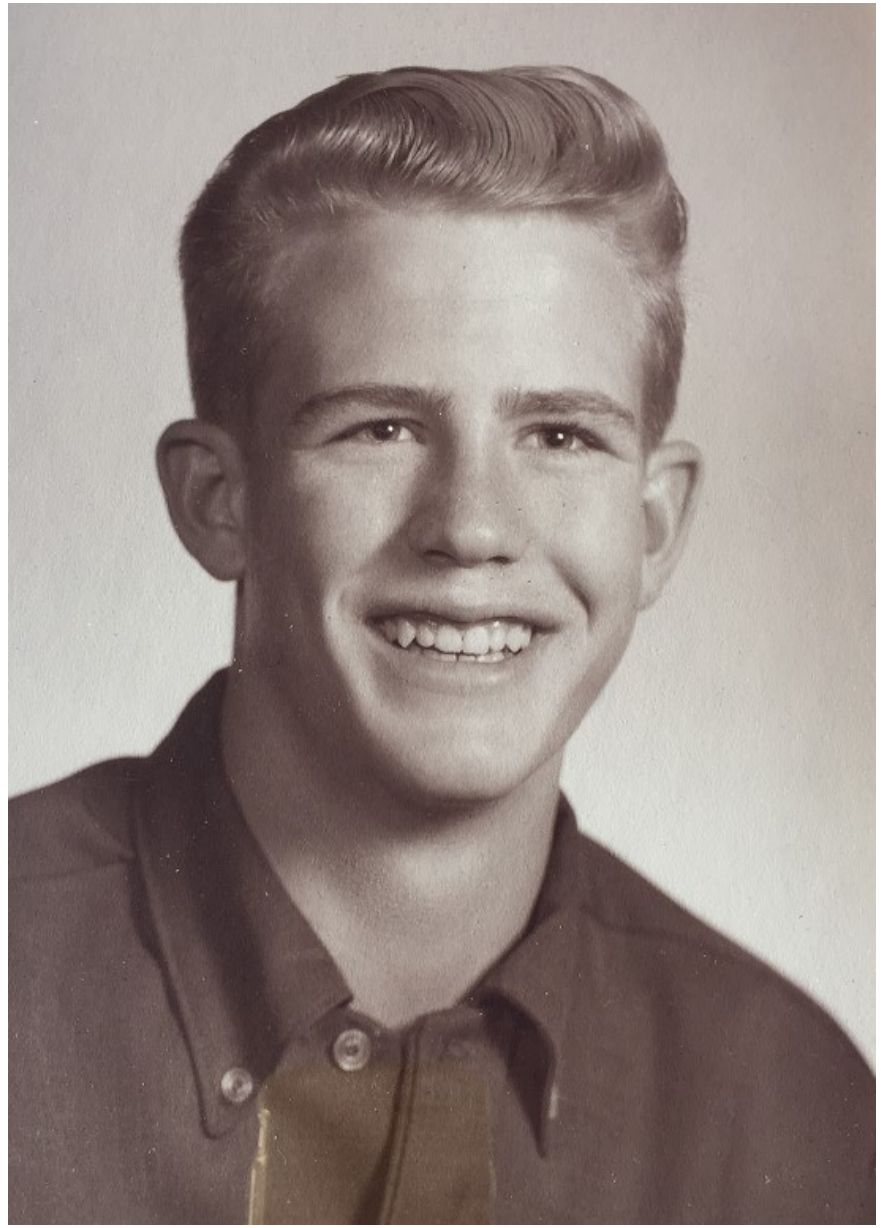
Before 1980

2. First experience with lightning occurred when plowing a field I about 1966

– a field never plowed before –

full of 10 foot tall sagebrush.

To me life is a spiritual journey, a journey which I only expect to leave with my experiences and my friends.

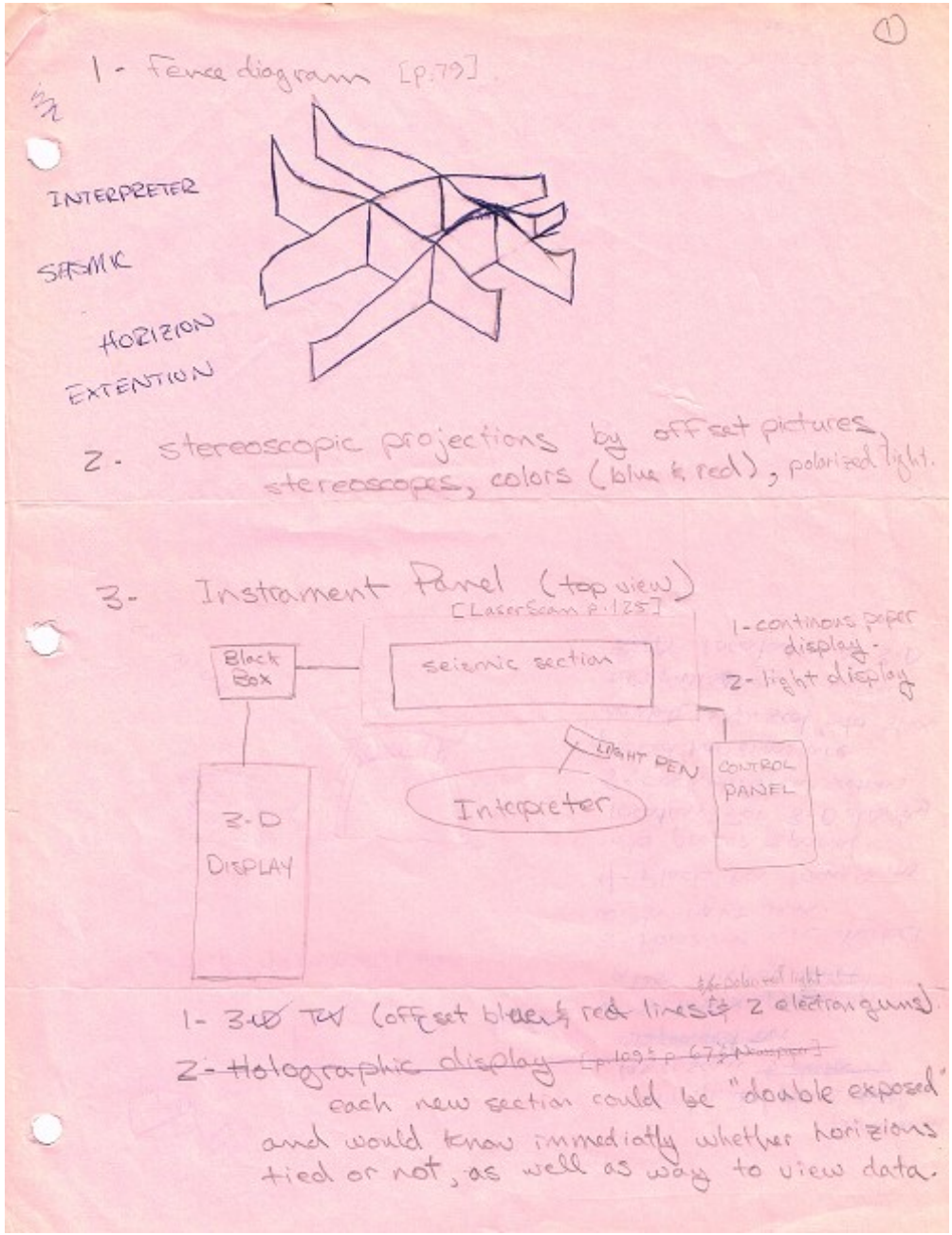


Before 1980

3. Summer Internships:

- 1970 Pan American Denver
  - Posting interpreter picks

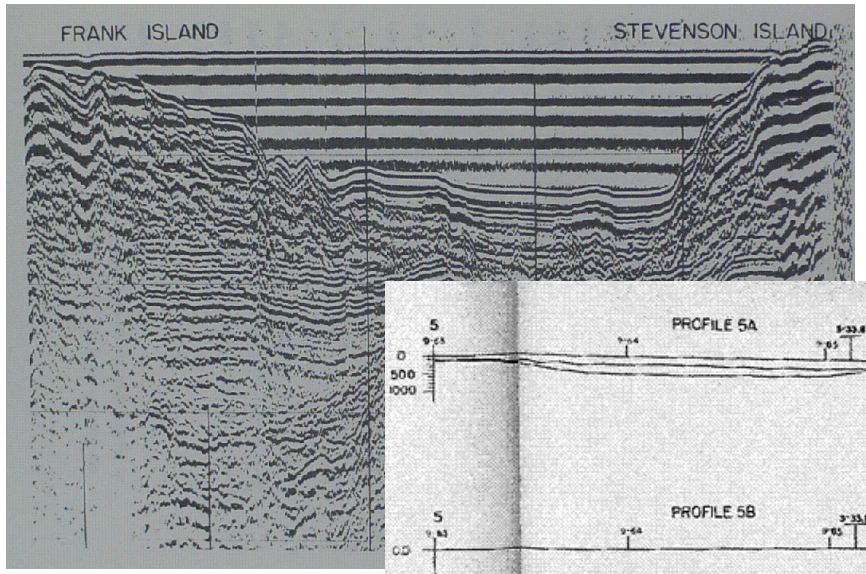
- 1973 Amoco Denver:
  - Teletype Seismic Array Response Curves from a computer in Tulsa

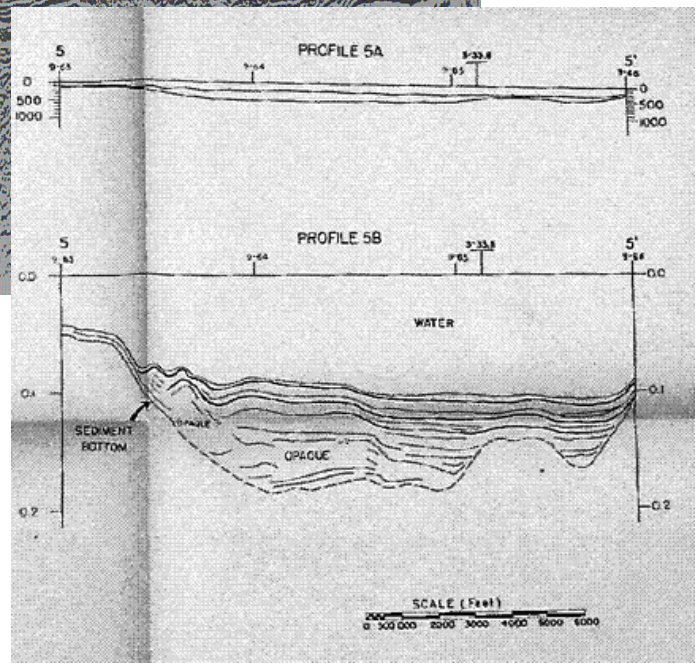


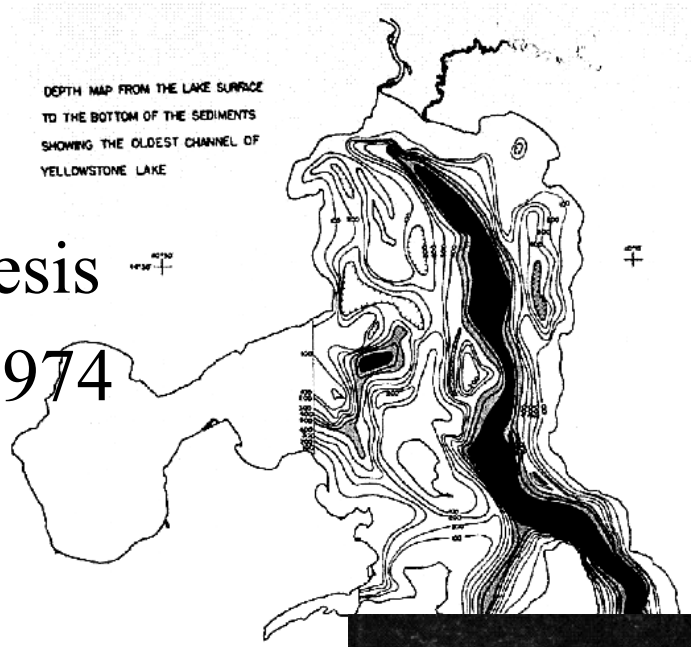
Before 1980

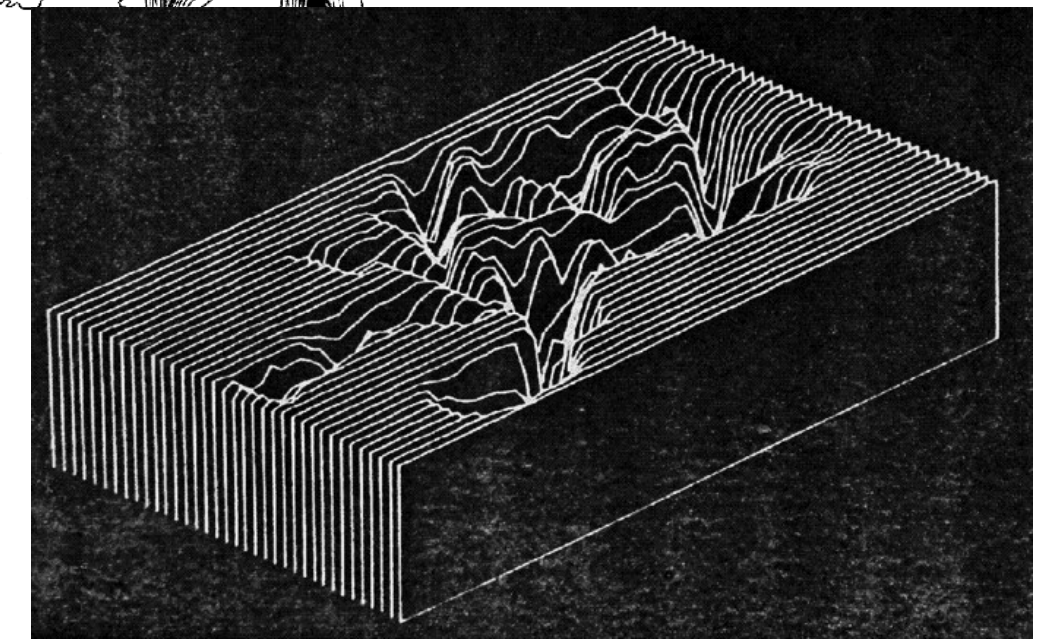
4. University of Utah Senior Thesis

May 1974







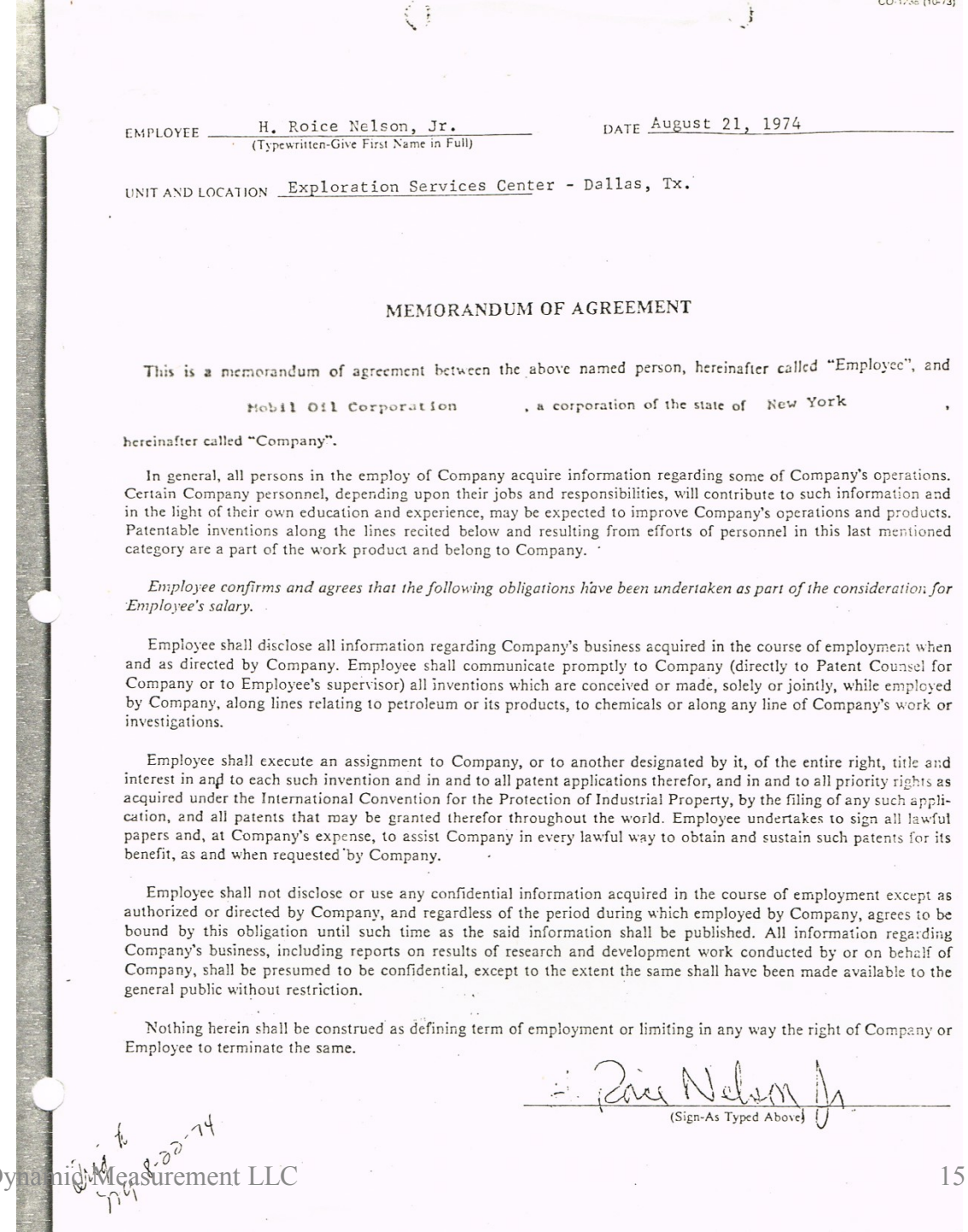


Before 1980

5. 15 July 1974

First Day at Mobil Oil:

- Refusal to sign Mobil's Patent Release Form
- Meeting Bob Peacock Manager for ESC
- 11 August 1974 Memorandum of Agreement



EMPLOYEE H. Roice Nelson, Jr. (Typewritten-Give First Name in Full) DATE August 21, 1974

UNIT AND LOCATION Exploration Services Center - Dallas, Tx.

MEMORANDUM OF AGREEMENT

This is a memorandum of agreement between the above named person, hereinafter called "Employee", and Mobil Oil Corporation, a corporation of the state of New York, hereinafter called "Company".

In general, all persons in the employ of Company acquire information regarding some of Company's operations. Certain Company personnel, depending upon their jobs and responsibilities, will contribute to such information and in the light of their own education and experience, may be expected to improve Company's operations and products. Patentable inventions along the lines recited below and resulting from efforts of personnel in this last mentioned category are a part of the work product and belong to Company.

Employee confirms and agrees that the following obligations have been undertaken as part of the consideration for Employee's salary.

Employee shall disclose all information regarding Company's business acquired in the course of employment when and as directed by Company. Employee shall communicate promptly to Company (directly to Patent Counsel for Company or to Employee's supervisor) all inventions which are conceived or made, solely or jointly, while employed by Company, along lines relating to petroleum or its products, to chemicals or along any line of Company's work or investigations.

Employee shall execute an assignment to Company, or to another designated by it, of the entire right, title and interest in and to each such invention and in and to all patent applications therefor, and in and to all priority rights as acquired under the International Convention for the Protection of Industrial Property, by the filing of any such application, and all patents that may be granted therefor throughout the world. Employee undertakes to sign all lawful papers and, at Company's expense, to assist Company in every lawful way to obtain and sustain such patents for its benefit, as and when requested by Company.

Employee shall not disclose or use any confidential information acquired in the course of employment except as authorized or directed by Company, and regardless of the period during which employed by Company, agrees to be bound by this obligation until such time as the said information shall be published. All information regarding Company's business, including reports on results of research and development work conducted by or on behalf of Company, shall be presumed to be confidential, except to the extent the same shall have been made available to the general public without restriction.

Nothing herein shall be construed as defining term of employment or limiting in any way the right of Company or Employee to terminate the same.

H. Roice Nelson Jr.
(Sign-As Typed Above)

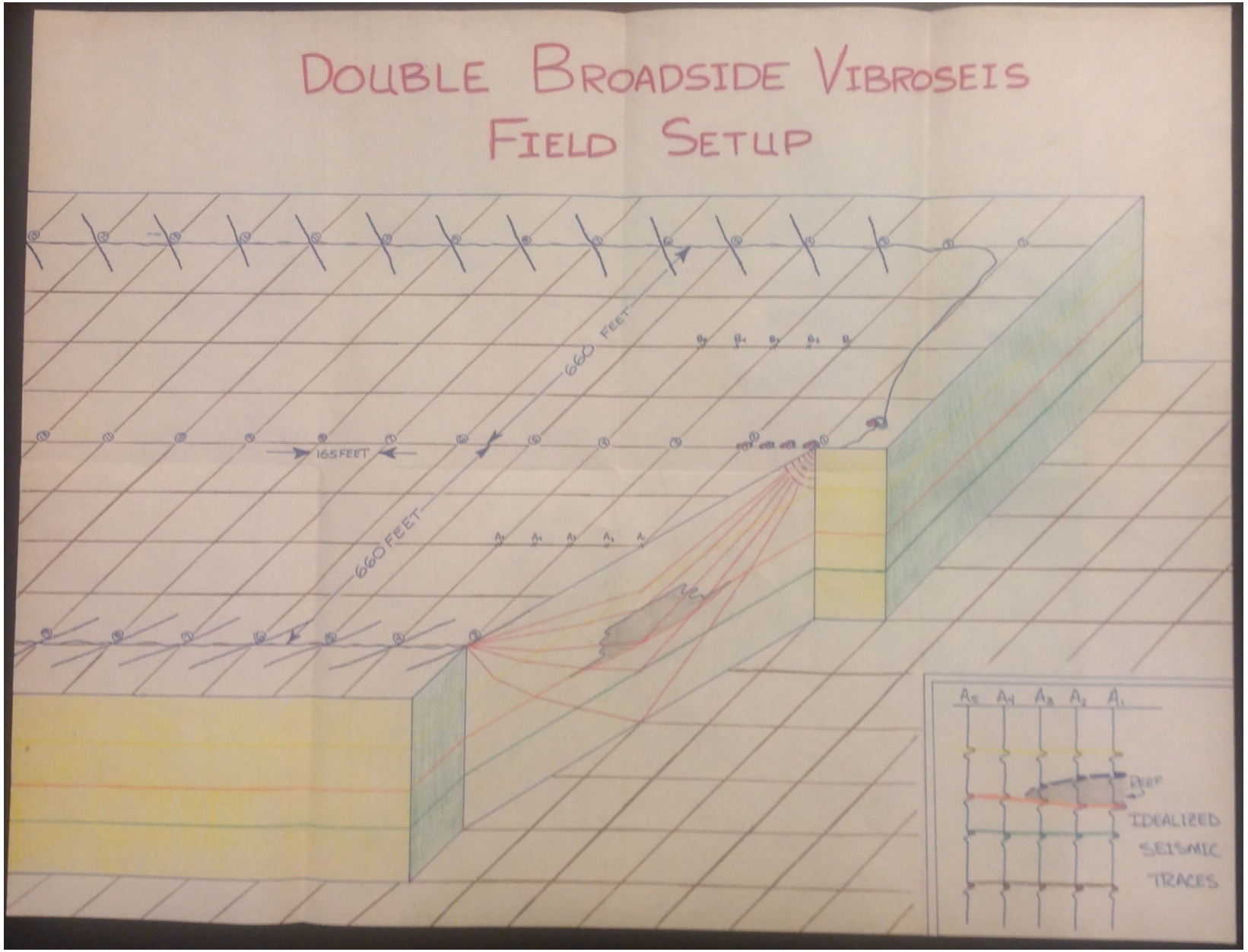
8-22-74

Before 1980

6. Mobil Training:

- Seismic Interpretation
  3-D Plastic Model
  November 1974

- Seismic Acquisition
  Michigan & Nigeria
  February 1975



Before 1980

7. 22 Dec 1975

Memo to MEPSI Boss

"Possible application of an interactive terminal connected with ESC's computer facilities"

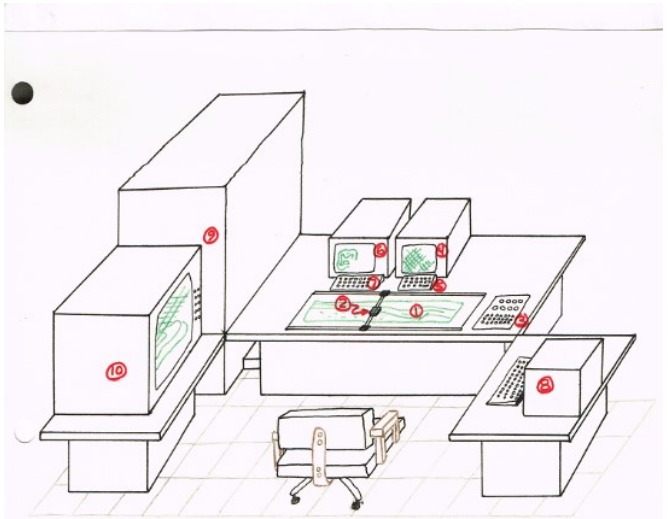


Figure 2 - CONSOLE FOR INTERACTIVE 3-DIMENSIONAL INTERPRETATION

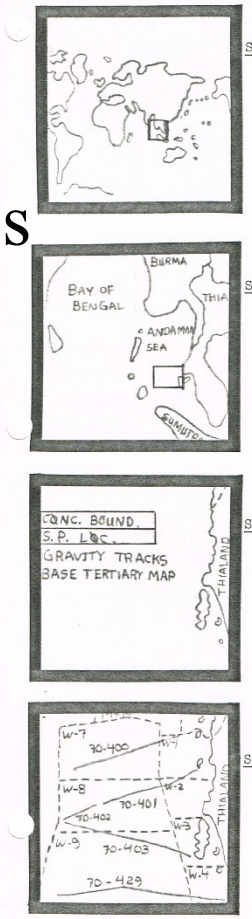
1. Seismic Section or Velocity Profile Display Unit
2. Digitizer
3. Control Board for 1. and 2.
4. Shot Point Location Display
5. Control Keyboard for 4.
6. Map Progress Display
7. Control Keyboard for 6.
8. Interactive Terminal for Data Location and Retrieval
9. Represent Hardwired Device that Converts Digitized Data to Format Compatible with 3-D Display Unit
10. 3-D Display of Interpretation Progress Step by Step

DRAFT

December 22, 1975

To J. C. Peffer

Figure 1. POSSIBLE STEPS IN OBTAINING A DESIRED DISPLAY



STEP 1 Log in interactive terminal and request display of world.

STEP 2 Display of world. Divided into blocks of 20° latitude by 20° longitude. Using keyboard or light pen the blocks desired can be displayed for the next step.

STEP 3 Display of the region of interest. Divided into smaller blocks dependent in size on the number blocks requested in Step 1. The exact area of interest is specified so it can be displayed for the next step. A listing of what has been digitized and is on file for this area is also requested.

STEP 4 Display of an area of interest with list of data that can be displayed. Pick of what is desired for display. For example seismic coverage may be desired.

STEP 5 Display of seismic coverage for area of interest. Can have the CRT swept and make a paper copy of this display for reference. If additional displays are desired,can then request they be generated, displayed and copied one at a time (gravity tracts, magnetic tracks, well locations, previous maps of area, etc.).

POSSIBLE APPLICATIONS OF AN INTERACTIVE TERMINAL CONNECTED WITH ESC'S COMPUTER FACILITIES

INTRODUCTION

This memo describes a tool, the interactive terminal, and its potential use in storing data and keeping track of data storage locations for quick and easy retrieval. The need for improving the present data storage and retrieval system is emphasized by the large quantities of data presently being handled, the probable future amounts of data, and the inefficiencies of the present system. Also presented are ideas of possible extensions of this system.

List of Illustrations

The Interactive Terminal and Compatible Data Types

Interactive terminals provide airline companies with a quick and efficient way of handling and editing large amounts of data (flight schedules, passenger lists, etc.). In the same manner, MEPSI personnel could use this device to search for information on file and keep an up to date listing of available data for each area on a worldwide basis with instant turnaround time.

“Three Dimensional Seismic Interpretation”

Before 1980

8. 17 May 1977

Memo to SEP Boss

INTEROFFICE CORRESPONDENCE

DATE May 17, 1977

TO C. Gans

CC

7.32.81.3
THREE DIMENSIONAL
SEISMIC INTERPRETATION

Definition

Three Dimensional Seismic Interpretation: The determination of geological significance from seismic data by interpreting, with a digitizer, structural pattern on a seismic section, and displaying the resulting geologic surfaces, via a computer, in a position proportional to that surfaces' true location in the earth; i.e., by exhibiting the interpreted surfaces on a three dimensional display unit.

Introduction

The ideas presented in this paper, although not at all new, are not yet being concurrently applied by industry and particularly not by Mobil. Earth scientists have been building three dimensional models of the earth for years. However, the man hours required to make a plaster of paris model, or even a fence diagram, make 3-D model making an exercise in futility for virtually all interpretation projects.

The purpose of this memo is to suggest an alternate method of seismic interpretation, to introduce a practical three dimensional display unit, and describe how this unit could be applied in geological and geophysical interpretation projects. There are areas where the theory needs to be worked on. However, the two basic premises are felt to be valid: (1) in order to obtain a more accurate interpretation of the subsurface, all available valid data describing that area should be displayed and interpreted relative to its true position in the earth; and (2) that it is possible to build a three dimensional display unit, that will exhibit a seismic interpretation in its relative earth position with a real time turn around.

The overall concept, a possible procedure to follow in doing this type of interpretation, as well as the makeup and workings of a possible 3-D model are described in some detail. Various possible applications of the 3-D model are also presented. One major result of developing a way to apply the concepts brought together in this paper, would be to eliminate much of the clerical, coding, and drafting work that takes up such a large percentage of an interpreters time under present interpretation procedures. It is felt that not only effectiveness, and thus the cost, but also the accuracy of interpretations could be significantly improved.

LIST OF FIGURES

* Examples of hardware presently available.

** Contractor data gathering procedures available.

Before 1980

9. Classic Memo:
"Down the road"
"Not enough demand
or need for it now."
11 Nov 1977

Steward Moncrief (1990):
Spectrum-colored map Offshore Falkland Islands 1977

DATE November 11, 1977

TO ~~C. P. Menard~~ CC

THREE DIMENSIONAL
SEISMIC INTERPRETATION
H. R. NELSON

Attached is Roice Nelson's 3-D interpretation summary along with comments made by various people whom I asked to review the system.

You will note that parts of this have been tried before, but interest was never great enough to sustain a continuation of development. Personally, I would rather have a good contour map than a 3-D projection except for show and tell situations.

I think this type of system is down the road because there is not enough demand or need for it now.

G. E. Noble

GEN:spb
Attachments

Before 1980

10. “Tektronix does not have any interest in pursuing this application area.

Tektronix
COMMITTED TO EXCELLENCE

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Phone: (503) 644-0161
TWX: 910-467-8708

ext. 7471

December 12, 1977

Mr. H. Roice Nelson, Jr.
3332 Lockmoor
Dallas, Texas 75220

Dear Mr. Nelson:

The proposal you discuss in your letter of December 2 sounds like a new business and market for Tektronix which has much broader implications (as you suggest) than just a new product.

Since that is the case, I'm referring your resume and letter to Ian Garbutt of our New Ventures group. He has the responsibility of evaluating new business for Tektronix and if they are attractive to us, determining the best initial approach that we should pursue.

Sincerely,

Dean Butts

Dean Butts, Manager
T&M Marketing Services

DB/vl

cc: Ian Garbutt

Tektronix Interested
12 Dec 1977

Tektronix
COMMITTED TO EXCELLENCE

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Phone: (503) 644-0161
TWX: 910-467-8708

February 9, 1978

Ref: G78/0225

Mr. H. Roice Nelson, Jr.
3332 Lockmoor
Dallas, Texas 75220

Dear Mr. Nelson:

Confirming our recent telephone conversation, I am sorry to say that Tektronix does not have any interest in pursuing this application area for its display terminals in any great depth. Therefore, there is no appropriate position that we could offer you, but there may well be some need at a future date to approach you in a consulting capacity perhaps, should we decide to take a more active role.

I very much appreciate your interest in Tektronix and wish you well in your future endeavors.

Sincerely,

Ian R. Garbutt

Ian R. Garbutt

Manager
New Ventures Operations

IG:js
cc: Doyle Cavin
Larry Mayhew
Wim Velsink

AN EQUAL OPPORTUNITY EMPLOYER

Tektronix Not Interested
09 Feb 1978

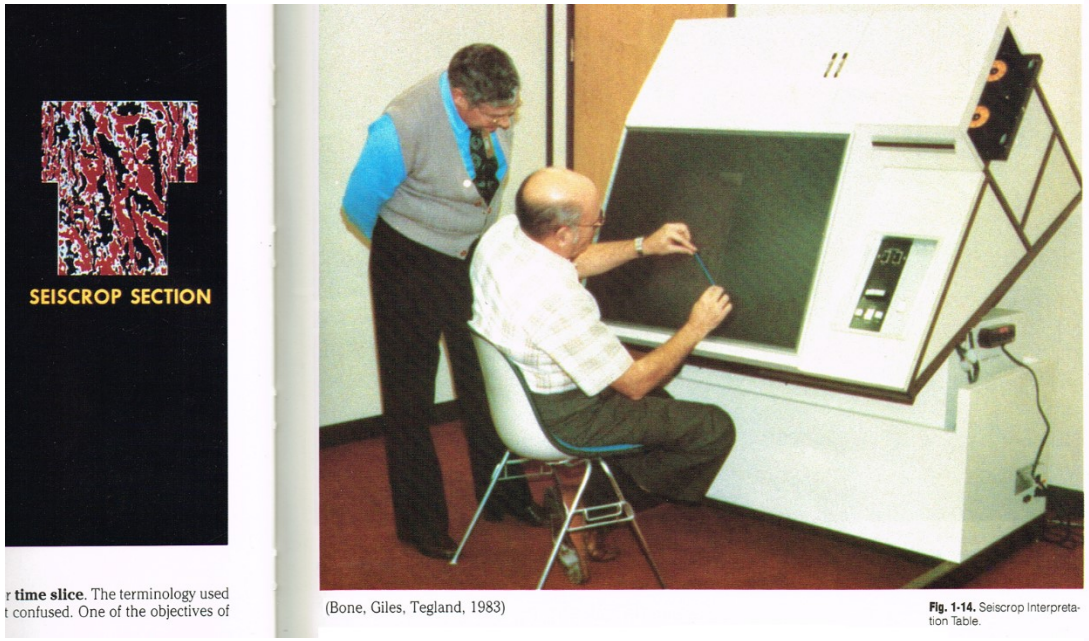
Before 1980

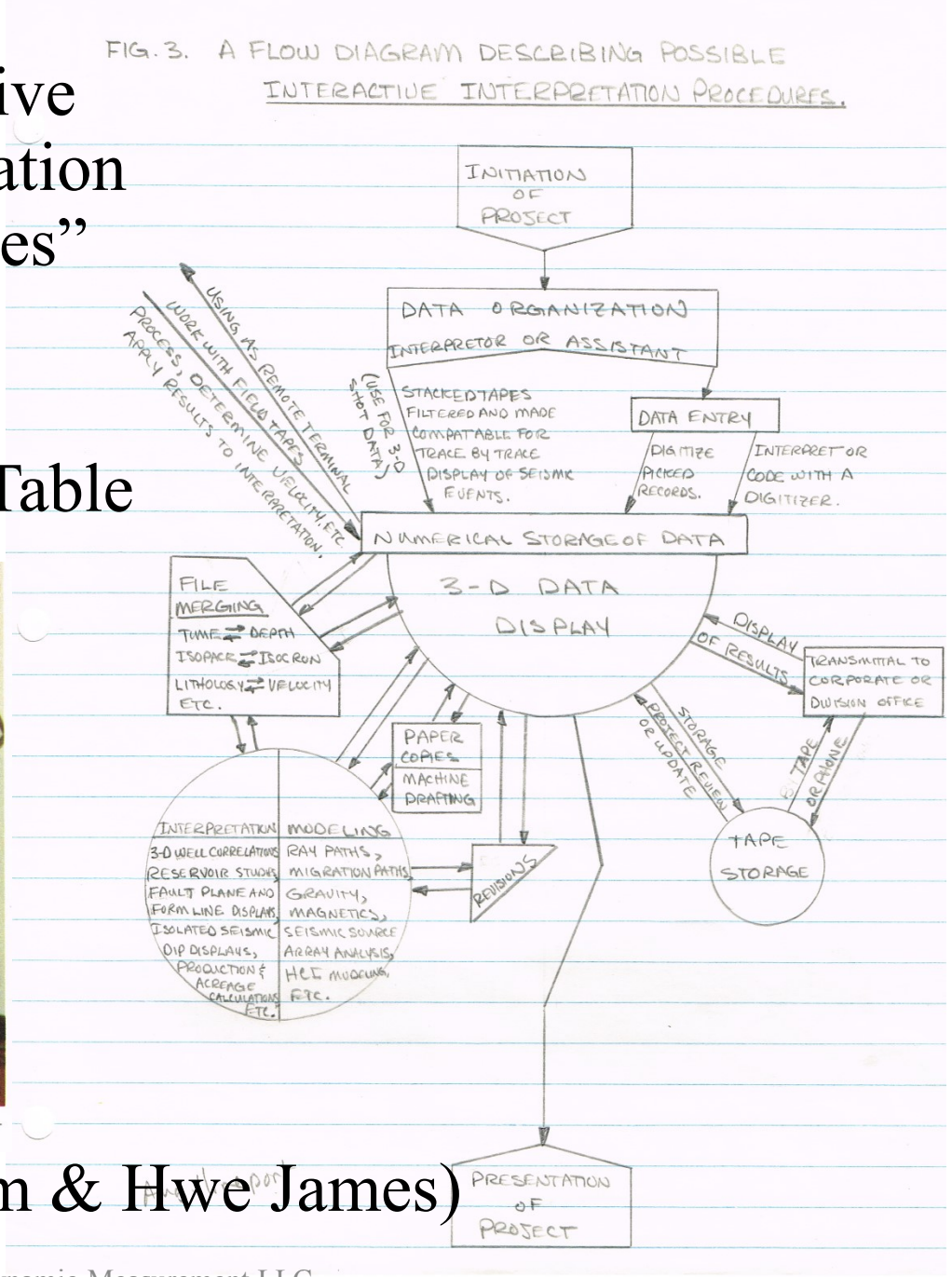
11. 11 Aug 1978

2nd Memo to SEP Boss

After hearing about GSI SeisCrop Table

"Interactive Interpretation Procedures"



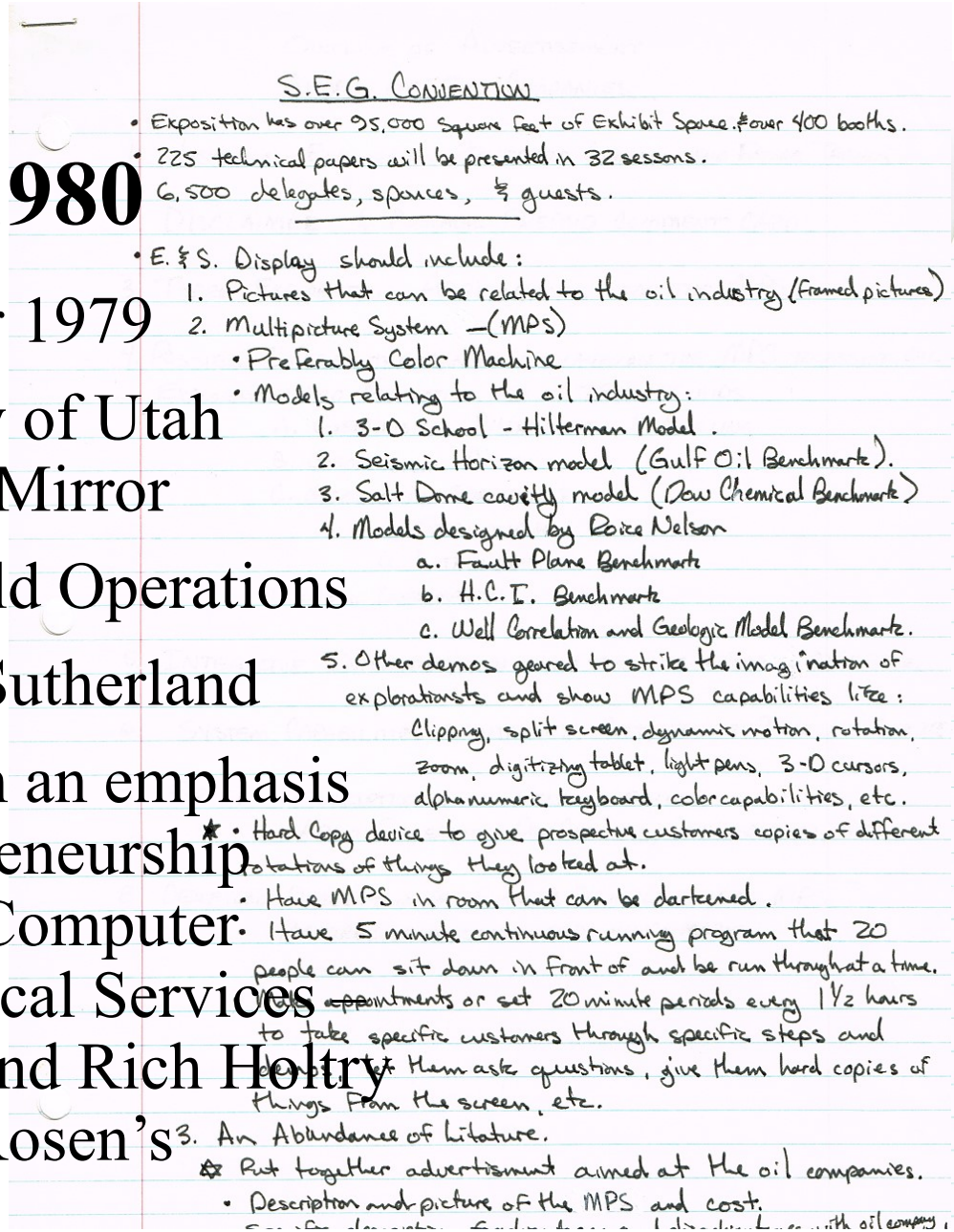


Herbert Hunt & ARCO (Aftab Alam & Hwe James)

Before 1980

12. Summer 1979

- University of Utah Vibrating Mirror
- Mobil Field Operations
- Evans & Sutherland
- MBA with an emphasis in Entrepreneurship at SMU (Computer Genealogical Services Ed Gray and Rich Holtry at Sevin-Rosen's Marstech)



S.E.G. CONVENTION

- Exposition has over 95,000 square feet of Exhibit Space. Over 400 booths.
- 225 technical papers will be presented in 32 sessons.
- 6,500 delegates, spouses, & guests.

- E. & S. Display should include:
  1. Pictures that can be related to the oil industry (Framed pictures)
  2. Multipicture System — (MPS)
     - Preferably Color Machine
     - Models relating to the oil industry:
       1. 3-D School - Hilterman Model.
       2. Seismic Horizon model (Gulf Oil Benchmark).
       3. Salt Dome cavity model (Dow Chemical Benchmark)
       4. Models designed by Boice Nelson
          a. Fault Plane Benchmark
          b. H.C.I. Benchmark
          c. Well Correlation and Geologic Model Benchmark.
       5. Other demos geared to strike the imagination of explorationists and show MPS capabilities like: Clipping, split screen, dynamic motion, rotation, zoom, digitizing tablet, light pens, 3-D cursors, alphanumeric keyboard, color capabilities, etc.
     - ★ Hard Copy device to give prospective customers copies of different rotations of things they looked at.
     - Have MPS in room that can be darkened.
     - Have 5 minute continuous running program that 20 people can sit down in front of and be run through at a time. ~~appointments~~ or set 20 minute periods every 1½ hours to take specific customers through specific steps and ~~demonstrate~~ them ask questions, give them hard copies of things from the screen, etc.
  3. An Abundance of literature.
     - ★ Put together advertisment aimed at the oil companies.
     - Description and picture of the MPS and cost.

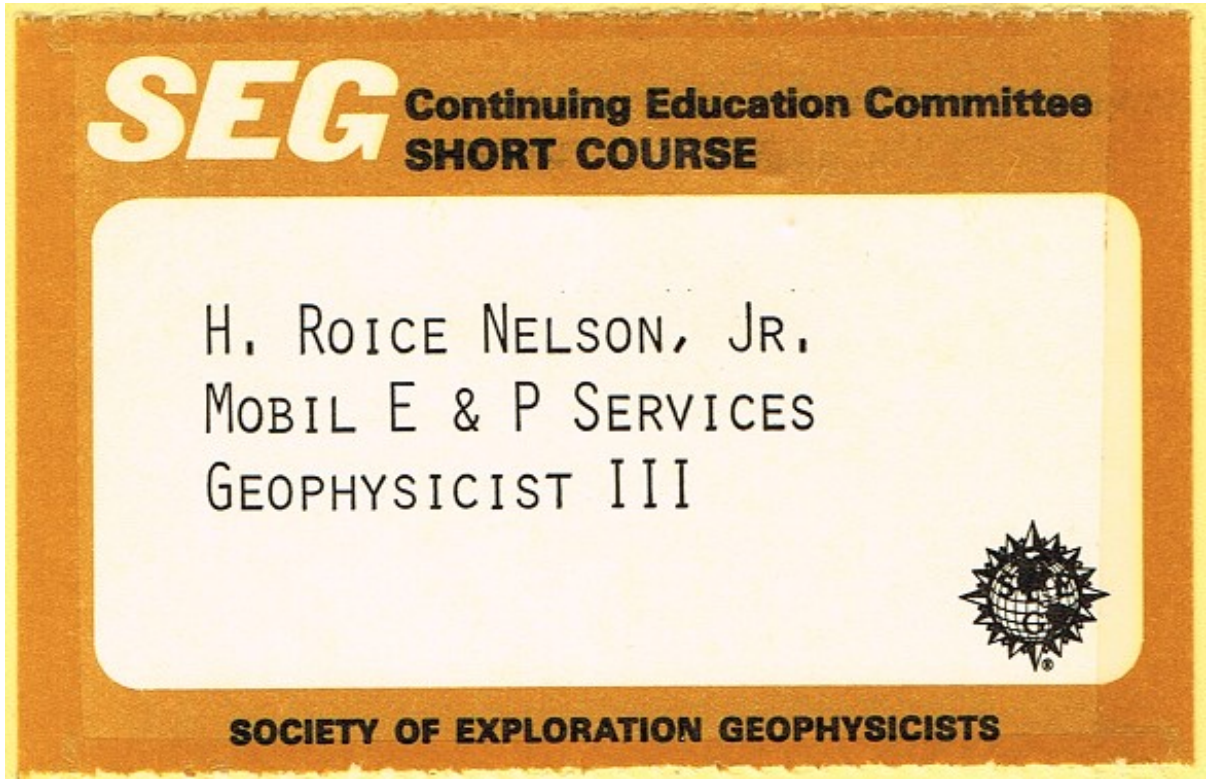
STEP TO GET 3D MODELS READY	a. Fault Plane Benchmark	b. H.C.I. Benchmark	c. Well Correlation and Geologic Model Benchmark.
① DIGITIZE BASEMAP			
② DROP VERTICAL		etc.	
③ INTERACTIVELY PUT DATA ON			
④ CONNECT DATA BETWEEN PLANES AND LINES.	DEFINE & DRAW FAULT PLANES BETWEEN SECTIONS — Connection lines at same height	DEFINE GAS, OIL, WATER CONTACTS BETWEEN SECTIONS	CONNECT HORIZON AND PRODUCTION TOPS TO MAKE 3D PICTURE
⑤ POLISH PRESENTATION	Different colored faults	different colored wedges — Automatic area and volume calculations	Different colored horizon tops, etc.

Before 1980

13. SEG's First 3-D Seismic Techniques School
Houston, Texas in the Fall of 1979

- Wayne Wade – E&S

- Dr. Fred Hilterman – U of Houston



Before 1980

14. 03 Nov 1979 New Orleans SEG

EXHIBITOR'S PERSONNEL ADMITTANCE VOUCHER
SOCIETY OF EXPLORATION GEOPHYSICISTS
49th ANNUAL INTERNATIONAL MEETING & EXPOSITION
Rivergate Exhibition Center
New Orleans, Louisiana / November 5-8, 1979

This voucher will authorize H. ROICE NELSON, JR.
an employee of EVANS & SUTHERLAND BOOTH NO. 1423
(Name of Exhibitor)

to enter the Exposition Area during the "set-up" and "move-out" periods and on show days from 7:30 a.m. to 5:00 p.m., November 2-9, 1979.

IMPORTANT: This voucher cannot be used for admission into the Exhibition Area. It must be completed and exchanged at the Registration Desk for a personalized admission badge. ONLY the badge may be used for admittance.

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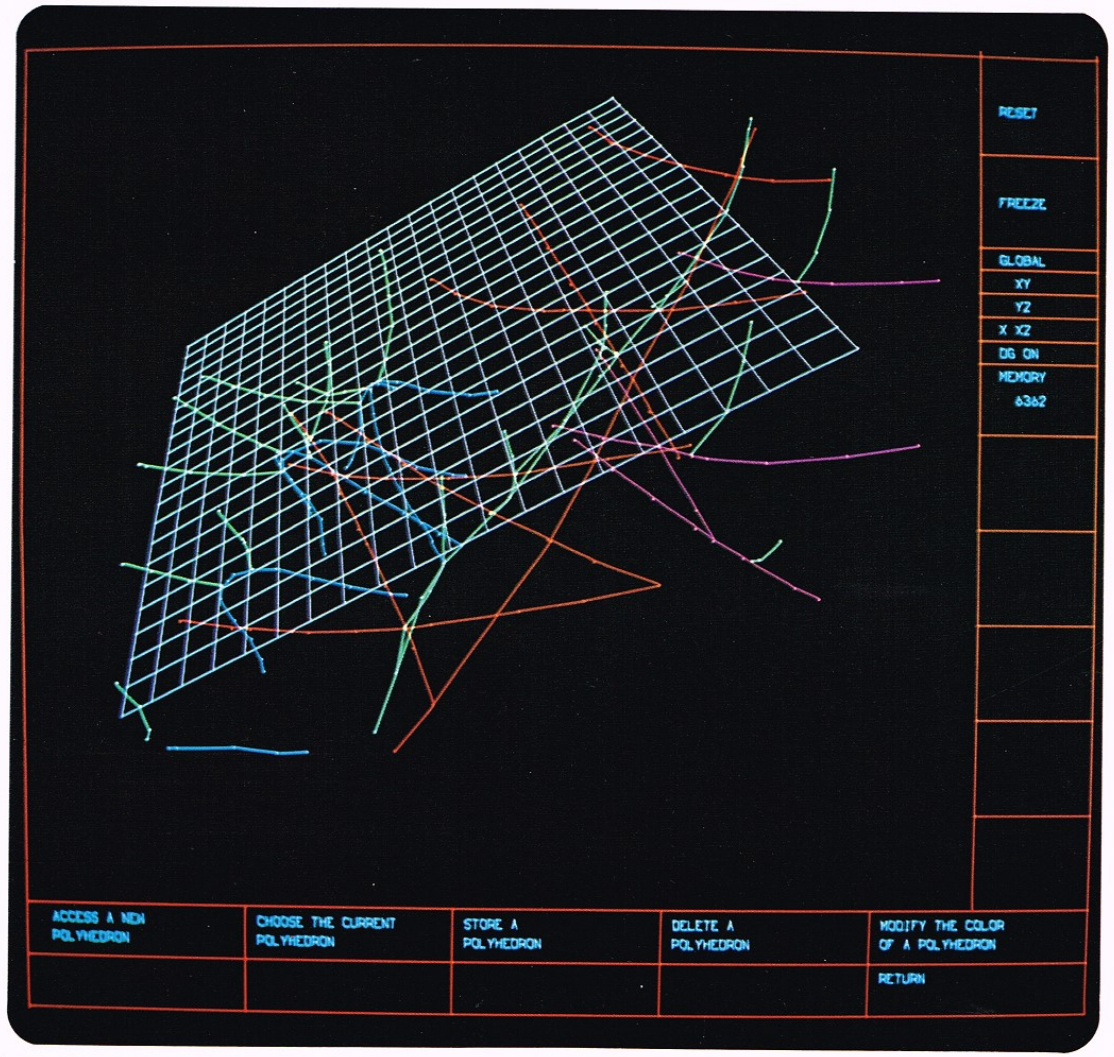
Address: 3332 LOCKMOOR LANE
City & State (or Province) DALLAS, TX 75220
Address during Annual Meeting (Hotel, etc.) HOLLIDAY INN EAST HIGH RISE

Convention Manager

EVANS & SUTHERLAND

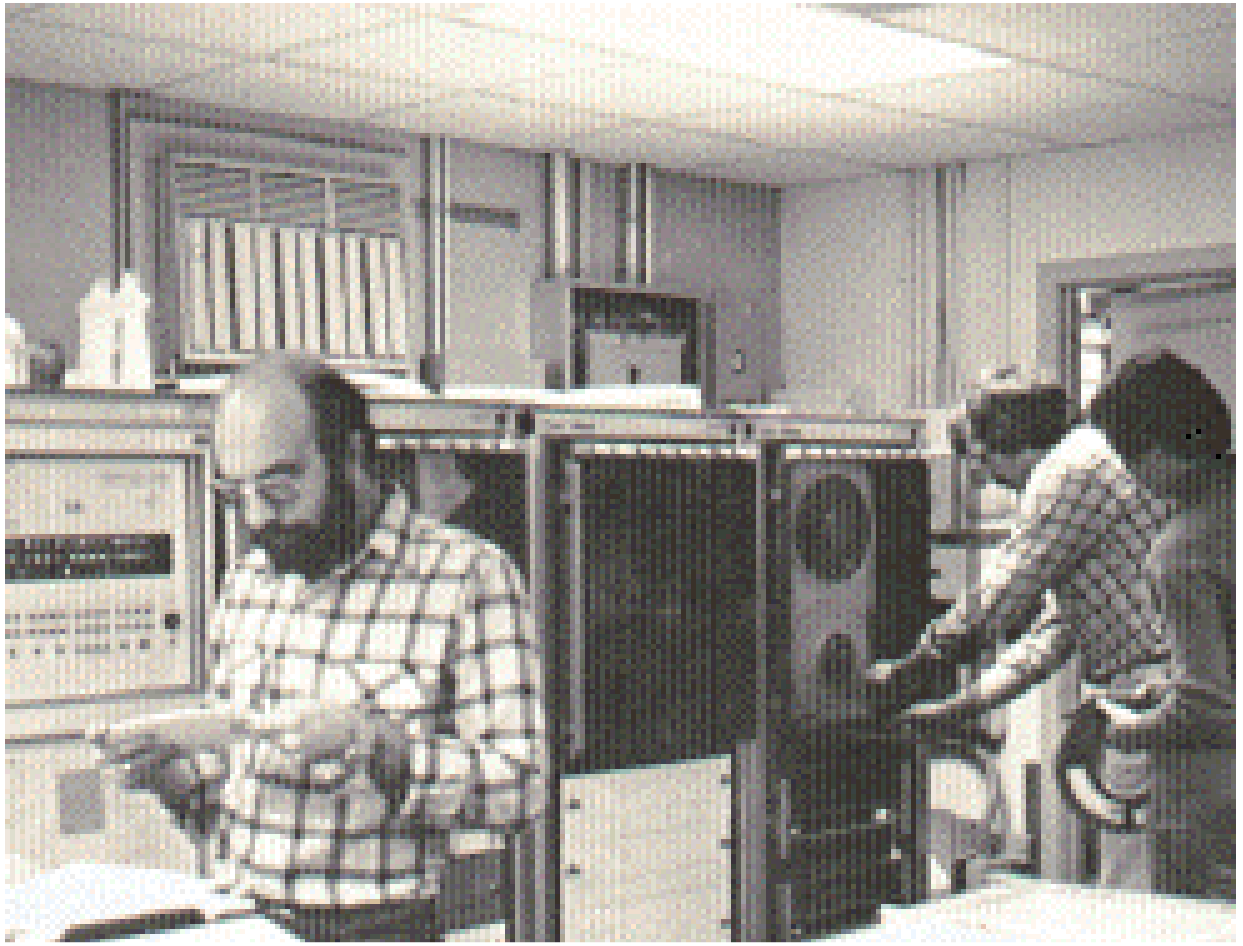


Seismic Data Analysis—The Picture System can be a powerful tool for interpreting seismic data. Here fault lines are displayed beneath a grid representative of the earth's surface. Color is used to identify lines belonging to a common fault plane.

1980-1982

15. 15 Jan 1980
Reported to:
The Seismic Acoustics Laboratory
at The University of Houston

Edip Basyl, Dr. Fred Hilterman,
Sharon Chang in photo



Dr. Richard Verm, Dr. Tom Smith, Dr. Tom Morgan, Dr. Anne Simpson, Dr. Olin Johnson, Dr. Lowell Harris, Barbara Murray, Dr. G.H.F. Gardner, Dr. John McDonald, Dr. Dan Kosloff, Dr. Moshe Reshef, Dr. David Kessler, Deepak Khosla, Dr. Sam Agbo, David Fisher, Guy Pernell, Chris Wade, K.K Sekharan, plus all of the AGL (FRL, SAL, RCL, IPL, WLL) and industry researchers.

GEOPHYSICAL ISSUE

1980-1982

16. 05 Oct 1981 O&G Journal

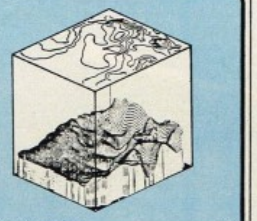
Introduction to interactive 3D interpretation

H. Roice Nelson Jr.
Fred J. Hilterman
G.H.F. Gardner
University of Houston
Seismic Acoustics Laboratory

Geophysical interpretation has not evolved at the same rate or to the same degree as instrumentation, processing, and field acquisition techniques in the last few decades. With the acceptance and widespread use of three-dimensional (3D) seismic techniques, there is an increased need for improved methods of manipulating, viewing, and interpreting a volume of data.

To this end, interactive computer graphics is gaining in usage because it allows both geophysical and geological data to be viewed simultaneously

Fig. 1
Perspective drawing*



*Of a contour surface

Fig. 2
Isometric fence diagrams

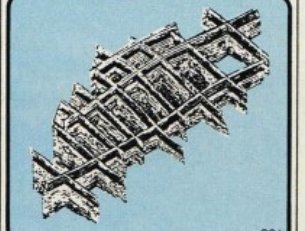


Fig. 3
Interactive data retrieval

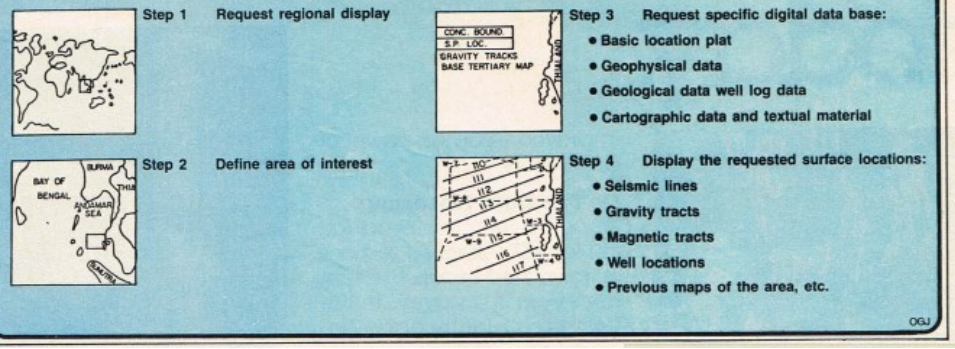
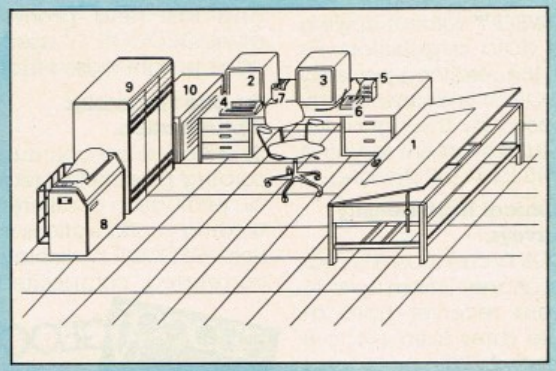


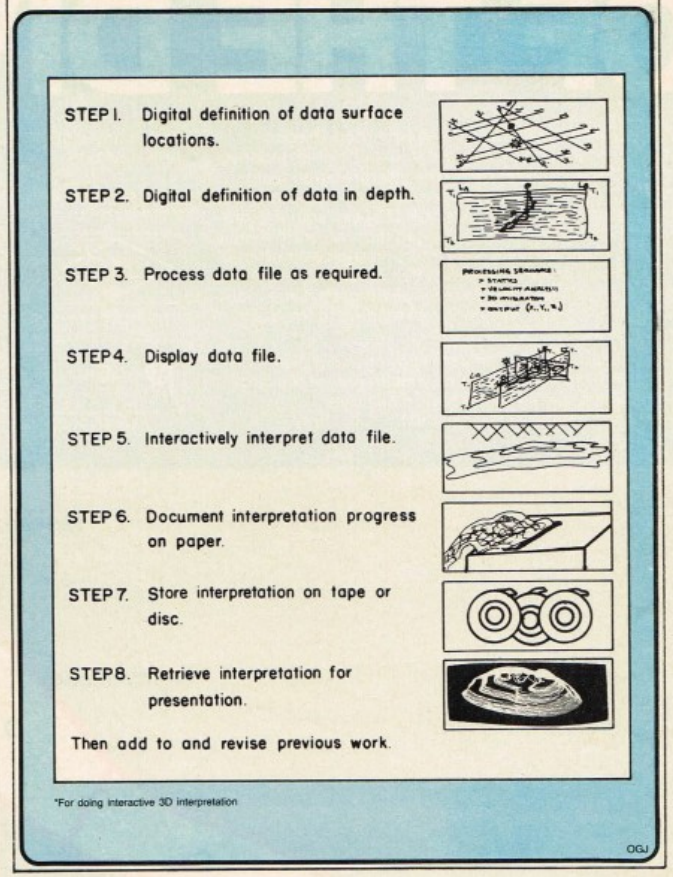
Fig. 4
Console arrangement*



1. Digital tablet
2. Color display of current interpretation
3. Black and white monitor—split screen with 4 viewing areas. This example shows a location map, contour progress, text, and a portion of a critical seismic section.
4. Alphanumeric keyboard
5. Control dials
6. Function switches
7. Joy stick
8. 22-in. electrostatic plotter
9. Supporting mini computer (optionally tied to main computer)
10. Graphics processor

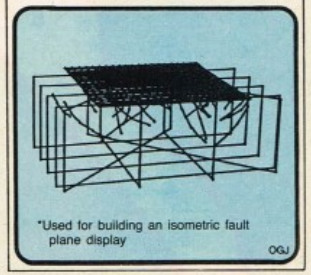
*For interactive 3D interpretation

Fig. 9
Eight generalized steps*



*For doing interactive 3D interpretation

Fig. 10
Fault picks*



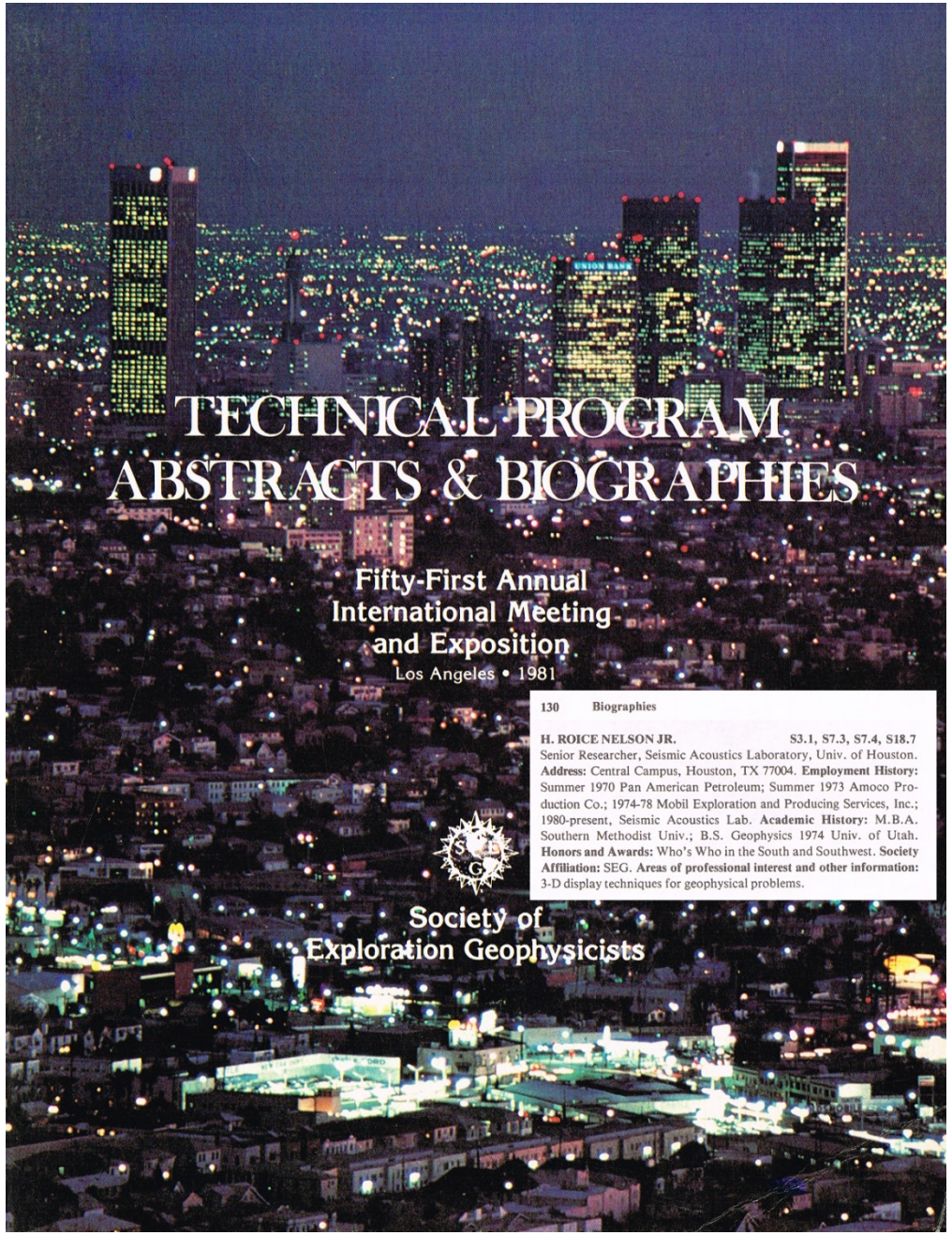
*Used for building an isometric fault plane display

http://www.walden3d.com/LandmarkFirsts/811005_First_Oil&Gas_Journal_Article.pdf

1980-1982

17. 11-15 Oct 1981
SEG Los Angeles

- S3.1 Seismic Shear-Wave Observations in a Physical Model Experiment
- S7.3 Three-Dimensional Display and Analysis of Seismic Volume Images
- S7.4 Interactive Geophysical Analysis with 3-D Color Graphics
- S18.7 Interpretation of Physical Model Tank Data With The Raster Segment Generator



1980-1982

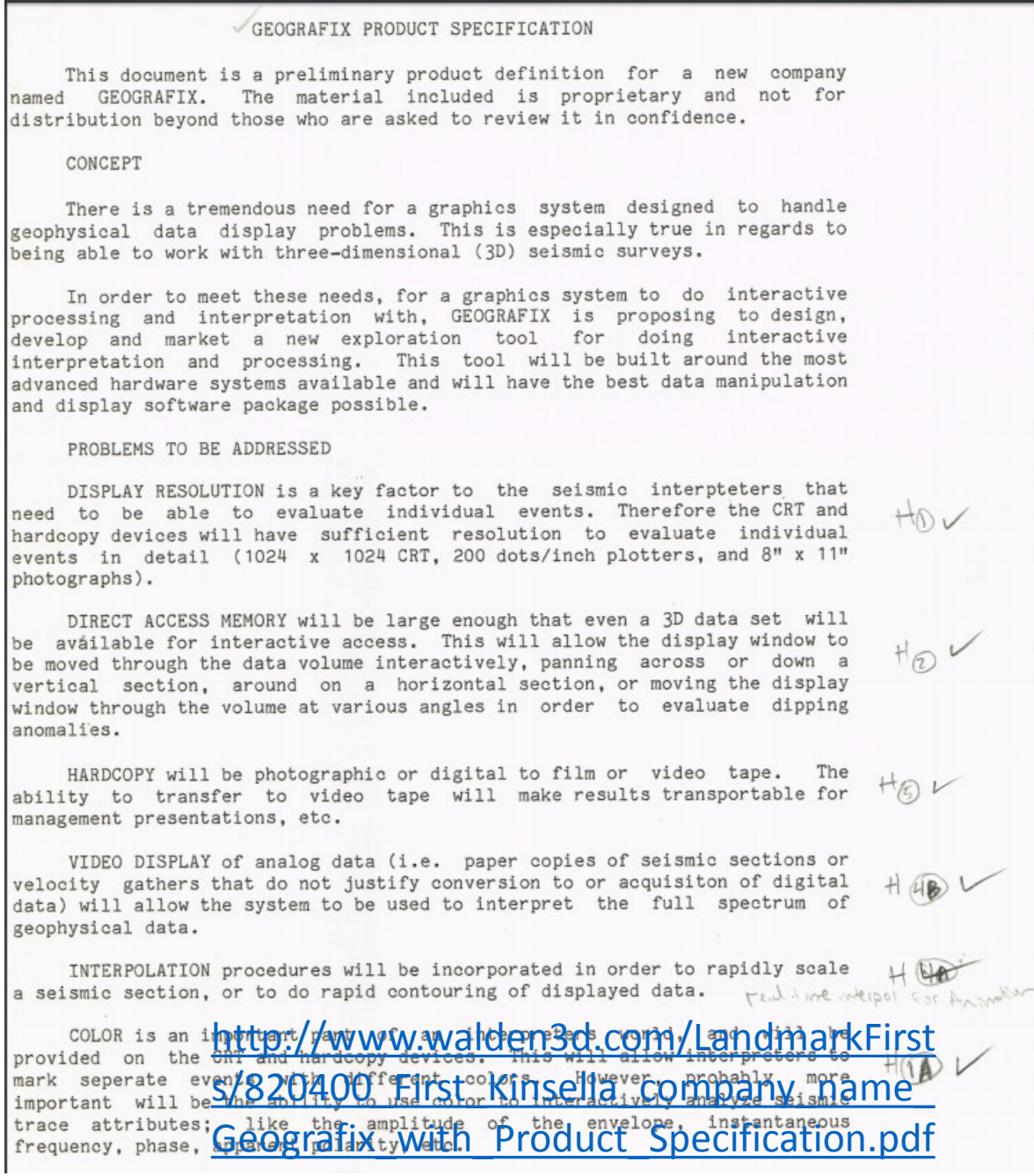
18. Christmas Break 1981

Kevin Kinsella

- Geophysical Development Corporation
  - Dr. Reginald Neale
  - Dr. John Sherwood
  - Dr. Fred Hilterman
- Don Paul, Chevron

Terry Smith, Digicon

John Amason, Texas Instruments



GEOGRAFIX PRODUCT SPECIFICATION

This document is a preliminary product definition for a new company named GEOGRAFIX. The material included is proprietary and not for distribution beyond those who are asked to review it in confidence.

CONCEPT

There is a tremendous need for a graphics system designed to handle geophysical data display problems. This is especially true in regards to being able to work with three-dimensional (3D) seismic surveys.

In order to meet these needs, for a graphics system to do interactive processing and interpretation with, GEOGRAFIX is proposing to design, develop and market a new exploration tool for doing interactive interpretation and processing. This tool will be built around the most advanced hardware systems available and will have the best data manipulation and display software package possible.

PROBLEMS TO BE ADDRESSED

DISPLAY RESOLUTION is a key factor to the seismic interpteters that need to be able to evaluate individual events. Therefore the CRT and hardcopy devices will have sufficient resolution to evaluate individual events in detail (1024 x 1024 CRT, 200 dots/inch plotters, and 8" x 11" photographs).

DIRECT ACCESS MEMORY will be large enough that even a 3D data set will be available for interactive access. This will allow the display window to be moved through the data volume interactively, panning across or down a vertical section, around on a horizontal section, or moving the display window through the volume at various angles in order to evaluate dipping anomalies.

HARDCOPY will be photographic or digital to film or video tape. The ability to transfer to video tape will make results transportable for management presentations, etc.

VIDEO DISPLAY of analog data (i.e. paper copies of seismic sections or velocity gathers that do not justify conversion to or acquisiton of digital data) will allow the system to be used to interpret the full spectrum of geophysical data.

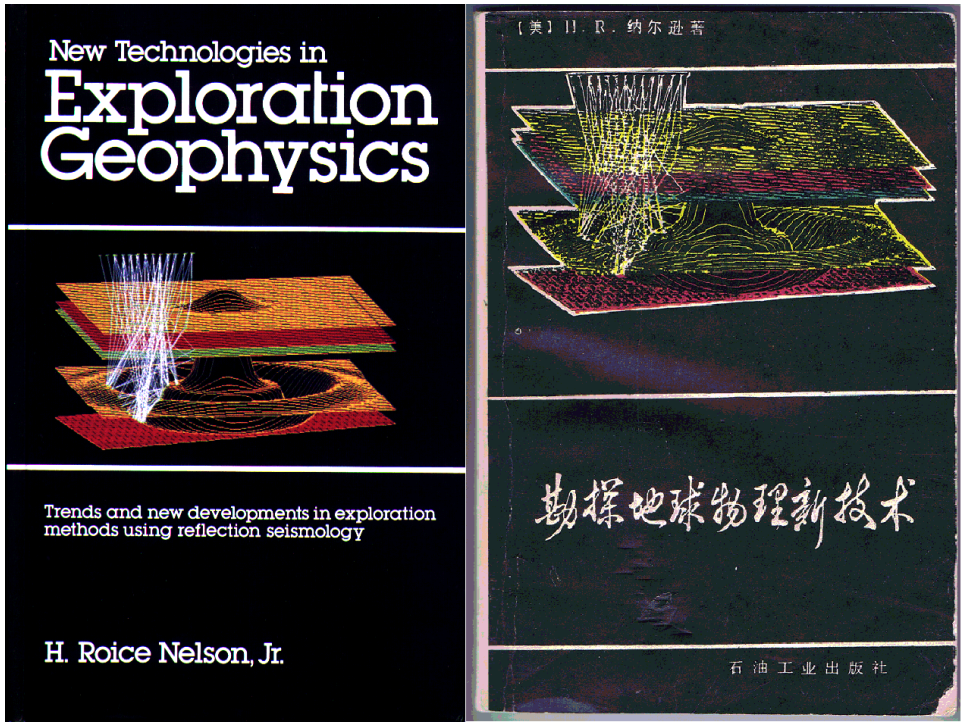
INTERPOLATION procedures will be incorporated in order to rapidly scale a seismic section, or to do rapid contouring of displayed data.

COLOR is an important part of [illegible] provided on the CRT and hardcopy devices. This will allow interpreters to mark seperate events with different colors. However, probably more important will be the ability to use color to interactively analyze seismic trace attributes; like the amplitude of the envelope, instantaneous frequency, phase, [illegible]

http://www.walden3d.com/LandmarkFirsts/820400_First_Kinsella_company_name_Geografix_with_Product_Specification.pdf

1980-1982

19. 11 Feb 1982 Gulf Publishing Advertising Bookstores 1 year later, China 3 years later



GULF PUBLISHING COMPANY

P. O. BOX 2608 HOUSTON, TEXAS 77001 713/529-4301

BOOK PUBLISHING DIVISION

February 11, 1982

Mr. Roice Nelson
General Manager
Allied Geophysical Laboratories
University of Houston
4800 Calhoun
A&E Building
Houston, TX 77004

Dear Mr. Nelson:

Having done some research into the matter, it is our feeling that the proposed book on geophysical exploration technology will sell well enough whether it is priced at $20 or $38.95. We will no doubt sell more copies at the lower price, and in the long run this is preferable. Accordingly I will be undertaking a survey, under the auspices of the International Association of Geophysical Contractors, to determine what market we can expect for the $20 book, in advance of printing. If the results of this survey indicate that we should run a printing of more than 3,000 copies, our retail price will begin descending from $38.95. Just how many extra thousands we print will ultimately determine the final retail price.

In any case we intend to publish the book, so I have enclosed our publishing contract for your signature. Please sign both copies in the indicated place, and be sure to have your signature witnessed. You must initial any changes you make, again on both copies.

I am also enclosing a questionnaire about you and the book. While a resume will suffice to answer most if not all the biographical questions, please do give careful consideration to the "about the book" portion. While answers to many of these questions seem obvious, it is still helpful to have an author express his own opinion of the market and the various ways of reaching it. Fill out the questionnaire at your leisure and return it to me sometime within the next six months.

It will be useful for us to meet soon, so I hope you can join me for lunch next week. I'll give you a call and see if we can set something up.

Cordially,

William J. Lowe
Editor in Chief

WJL:jr

http://www.walden3d.com/LandmarkFirsts/820211_First_Thick_Marketing_Brochure_Contract_Gulf_Publishing.jpg

1980-1982

20. 01 Mar 1982 First Course Outline

IHRDC

NEW TECHNOLOGIES IN EXPLORATION GEOPHYSICS

COURSE OUTLINE

H. Roice Nelson, Jr.

Day One

8:45		Registration
9:00	1.	Introduction
		* Instructor * Material to be covered * Course participants and backround * Review of reflection seismology
	2.	Energy Outlook
		* Open discussion
10:00		Break
10:15	3.	Multi-channel recording systems
12:00		Lunch Break
1:00	4.	Three-dimensional seismic techniques
2:30		Break
2:45	5.	Vector Processing
4:30		Wrap-up days activities

IHRDC

COURSE OUTLINE CONTINUED

Day Two

8:45		Open Discussion
9:15	6.	Seismic modeling
10:15		Break
10:30	7.	Computer graphics display of seismic data
11:30	8.	Color Hardcopy
12:00		Lunch
1:00	9.	True three-dimensional display devices
2:00		Break
2:15	10.	Decentralization and networking
3:15	11.	Satellite transmission and data base management
4:30		Wrap-up days activities

Day Three

8:45		Open discussion
9:00	12.	SALNOR interpretation workshop
12:00		Lunch
1:00	13.	Interpretating 3-D seismic surveys
2:00		Break
2:15	14.	Interactive Seismic Interpretation
3:15	15.	Non-seismic exploration techniques
3:45	16.	Hands-on training of explorationists
4:15		Wrap-up course and evaluation

IHRDC

137 NEWBURY STREET, BOSTON, MA 02116 USA Tel: (617) 536-0202 Telex: 94-0557 Cable: IHRDC-Boston

"Physical Modeling Book"

March 1, 1982

H. Roice Nelson
Seismic Acoustics Lab
University of Houston
Houston, Texas 77004

Dear Roice:

Thank you for your time in meeting with Cherry and me on February 23. I think we outlined a very successful short course at that time.

I do hope I get a chance to look at the outline and proposal for the Physical Modeling book in June.

I wish you the best with the geophysical technique book.

Sincerely,

Michael Hays
Publications Manager

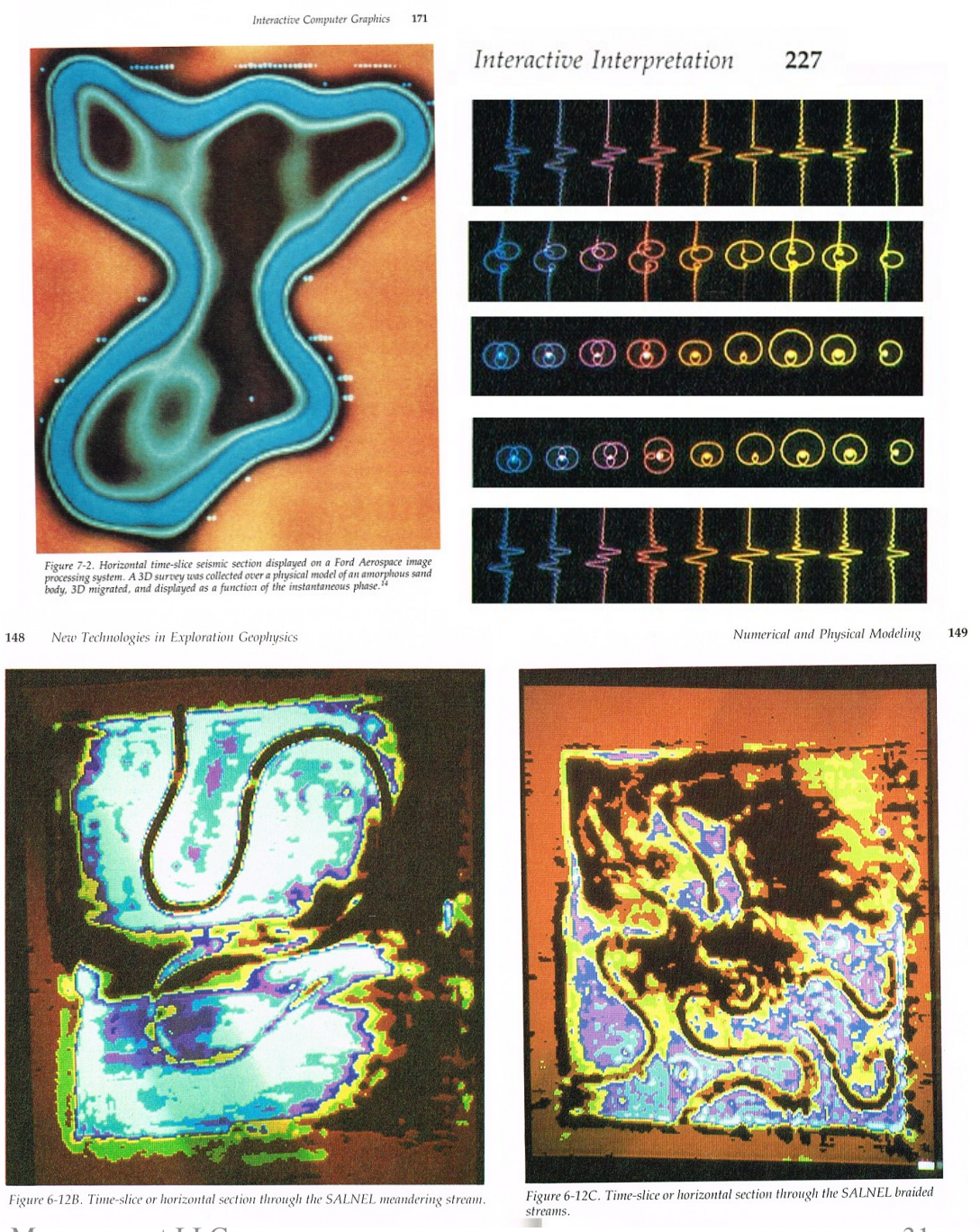
http://www.walden3d.com/LandmarkFirsts/820301_First_Short_Course_Outline_Agreement_IHRDC.jpg

INTERNATIONAL HUMAN RESOURCES DEVELOPMENT CORPORATION

1980-1982

21. **Zeitgeist** (the spirit of the times):

- Seitex later Paradigm – later Dr. Dan Kosloff
- GeoQuest Systems – the rich John Butler
- Gulf ISIS – G.H.F. Gardner & Walt Turpening
- GSI – Marion Bone & Allister Brown
- Arco - Aftab Alam & Hwe James
- BP HIVE – later Dave Roberts
- Chevron CHEVIS – Dave Bernie & Dick Cole
- Elf Aquitaine Candice – Phillipe Zaccanino
- Exxon ISIS – later Robert Steed
- Seiscom Delta MicroSeis – Hildebrand & Mouton
- Shell ISIS – Mike Dunn & Mike Forrest
- Texaco Visualization Theater – later Michael Zeitlin
- Texas Instruments Workstation – Gene Ennis
- Western Crystal– Aftab Alam
- Etc.



Interactive Computer Graphics 171

Interactive Interpretation 227

Figure 7-2. Horizontal time-slice seismic section displayed on a Ford Aerospace image processing system. A 3D survey was collected over a physical model of an amorphous sand body, 3D migrated, and displayed as a function of the instantaneous phase.[14]

148 New Technologies in Exploration Geophysics

Numerical and Physical Modeling 149

Figure 6-12B. Time-slice or horizontal section through the SALNEL meandering stream.

Figure 6-12C. Time-slice or horizontal section through the SALNEL braided streams.

1980-1982

22. January 1982 NPD School

Kristen land South, Norway

13 Apr 1982 John Dolman

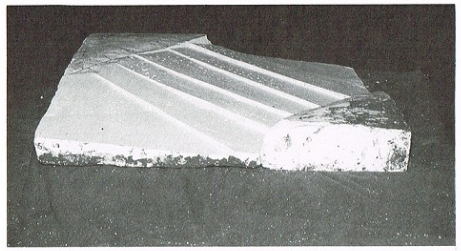


Figure 6-13B. A view of the SALNOR J-Unconformity plaster cast after it was shaved off to the Base Statford horizon.

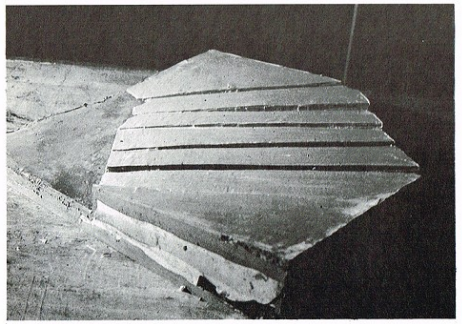


Figure 6-13C. The silicon rubber for deeper layers was added by pouring between the model and the plaster cast. This shows the SALNOR model after the Statford horizon had been poured.

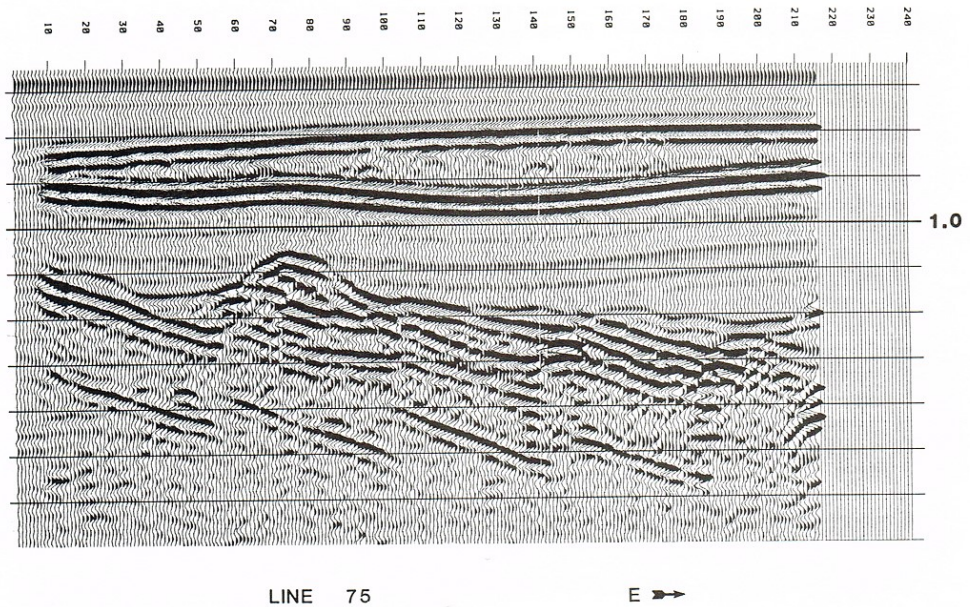


Figure 6–13D. An east-west vertical seismic section across the SALNOR model. The top three horizons represent the Top Paleocene, Top Cretaceous, and J-Unconformity. The other horizon easily recognized, which has four faults, is the Base Statford horizon.

Thames House North
Millbank London SW1P 4QG

Telephone 01-834 4444
Telex 21324

ICI Petroleum Services Limited

Dr. H. R. Nelson, Jr.,
Allied Geophysical Laboratory,
University of Houston,
Central Campus,
HOUSTON,
TX 77004,
USA

Your ref | Our ref JWD/AKM | Tel ext 4165/4573 | Date 13.4.82

Dear Roice,

Thank you for the information on the Allied Geophysical Laboratories. We have received your brochures on the laboratories and found your work of great interest to our Company. We would like to sponsor both your SAL and IPL projects. Our understanding is that the SAL project fees are £12,500/annum + £15,000 late penalty and the IPL project fee is £15,000/annum. If you could either send us your sponsorship forms or invoice, they will obtain our immediate attention.

Yours sincerely,

J. W. Dolman

http://www.walden3d.com/LandmarkFirsts/820413_First_Customer_ICI-Petroleum-Services-Ltd.jpg

1980-1982

23. Robert Stone Limbaugh
Digicon Marketing VP
Spring of 1982

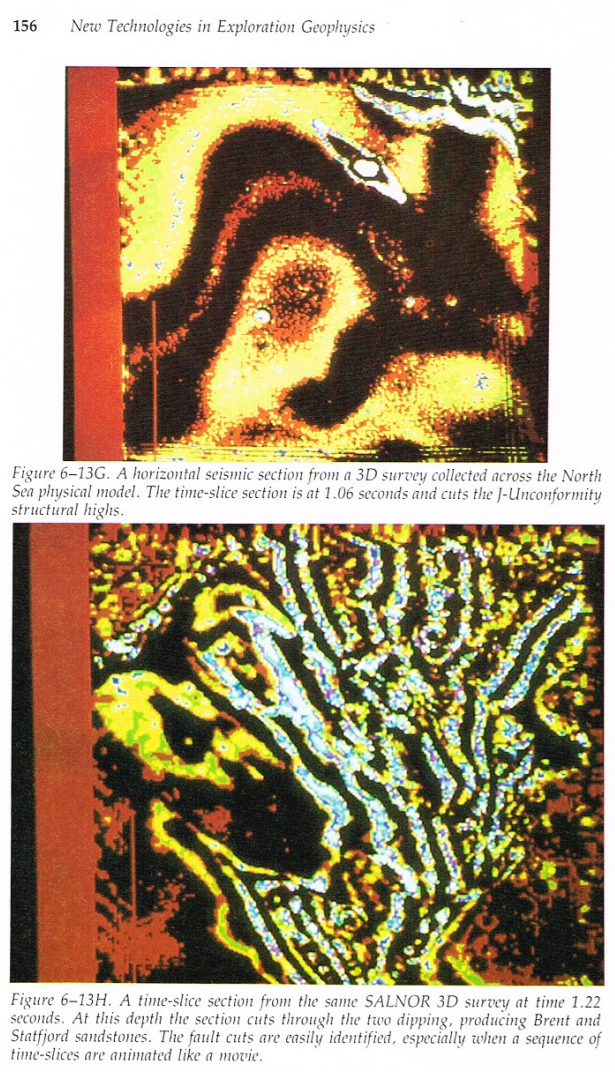
Also Founder
GeoQuest PDM

1980-1982

24. Landmark Graphics &
    Cyberan Geophysical
    After 1982 EAEG Cannes

Dr. Andy Hildebrand
Also Founder Auto-Tune

Dr. John Mouton
  Also Founder
  Object Reservoir



156 *New Technologies in Exploration Geophysics*

Figure 6–13G. A horizontal seismic section from a 3D survey collected across the North Sea physical model. The time-slice section is at 1.06 seconds and cuts the J-Unconformity structural highs.

Figure 6–13H. A time-slice section from the same SALNOR 3D survey at time 1.22 seconds. At this depth the section cuts through the two dipping, producing Brent and Statfjord sandstones. The fault cuts are easily identified, especially when a sequence of time-slices are animated like a movie.

1980-1982

HRN

DIAMOND GRAPHICS

The need for an interactive interpretation workstation and user-friendly supporting software is being met by the formation of a new company in Houston, Texas. The key individuals have been carefully selected to form the essential base required to start a new company. This well-banaced team of professionals have specific experience in and relating to:

* Seismic Interpretation
* Hardware Design and Implementation
* Software, both in
  -Operating Systems, and
  -Exploration Related
* Image Processing
* Exploration Marketing for Electronic Technology

The corporate charter is defined as follows:

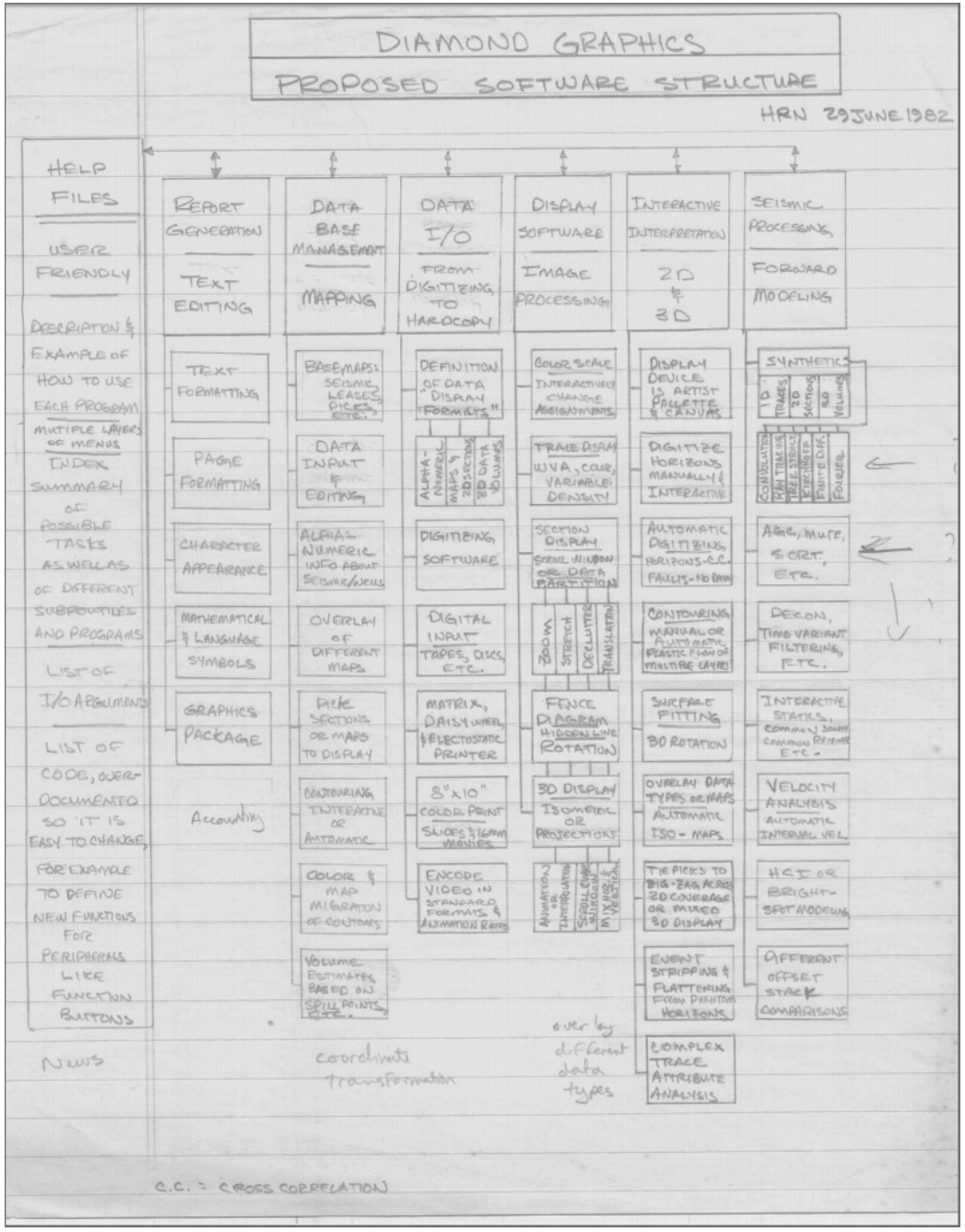
Design, develop and implement a state-of-technology interpretation work station, highly interactive, and employing:

* Data Base Technology
* High Resolution Color Raster Graphics
* High Performance Mega-Mini and Micro Computer Systems
* Interpretation Experience
* Image Processing

The current availability of systems leads one to the conclusion that companies offering systems draw primarily from their own experiences and talents. There lies herein a potential shortfall. Either the problem is understated or available technology is under used. This company is approaching the solution with the criteria that the key role is to TRANSFER graphics and related computing technology to the oil companies, with the primary contribution being in application software and solution identification.

25. June 1982 First Client Meeting

Westminster Tube Stop, London



1983-2007

26. Funding & Milestones

- Initial Funding 18 Jan 1983
  - CDC Capital Corporation
  - Novatec (Elf Aquitaine)
  - Sprout DLJ
  - Sevin-Rosen-Bayless
- IPO 28 Sep 1988
- Second Round 18 Aug 1989
- 1,000th System 24 May 1999
- 25th Year Celebration 2007

1983-1993

27. John Denham

EAEG 1983 Oslo

First Workstation Delivered

BHP Melbourne, Australia

"Map Displays from an Interactive Interpretation," Geophysics, v. 51, No. 10, pp. 1999-2006, Oct, 1986

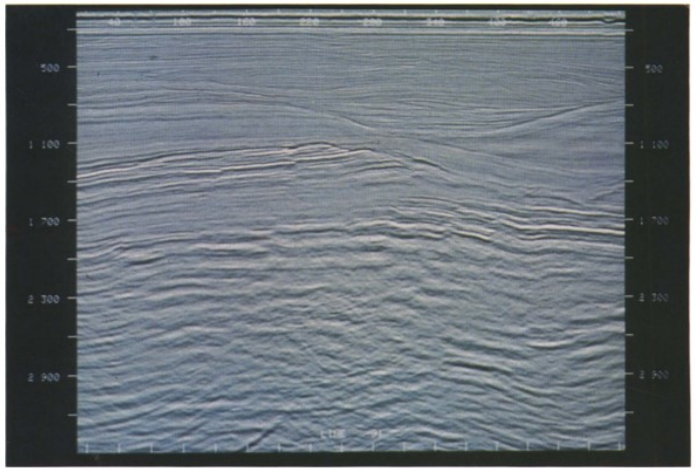


FIG. 1. Typical seismic section from the interpreted Gippsland Basin 3-D survey.

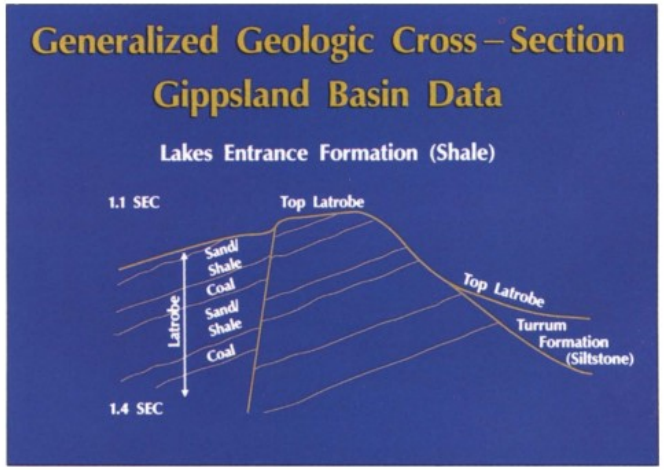


FIG. 2. Generalized geologic cross-section for the Gippsland Basin 3-D survey area.

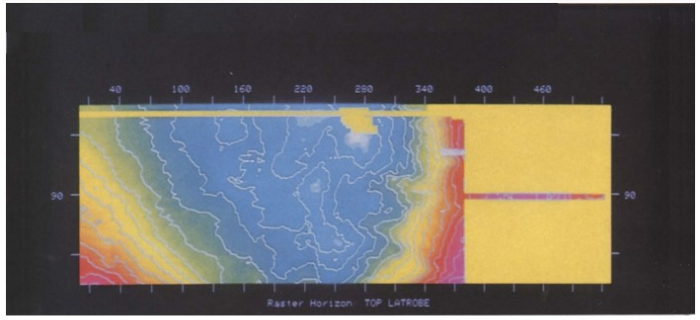


FIG. 4. Raw Top Latrobe horizon times as picked on each live trace of the 3-D survey, overlain with contours at 40 ms intervals. Whites and light blues are at about 1 100 ms, and the reds and violets are at about 1 400 ms.

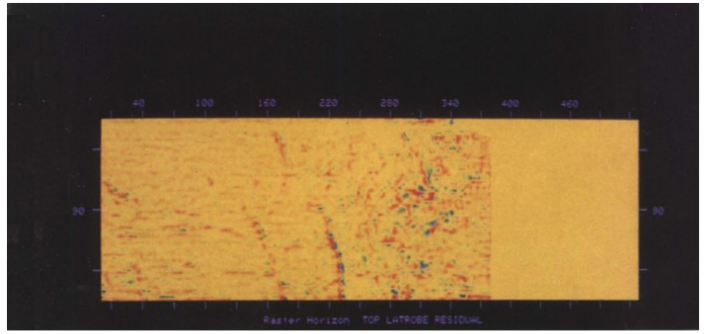


FIG. 6. A residual map created by subtracting the raw and filtered horizon files. The linear trends at traces 160 and 220 are fault cuts through the unconformity. Red is the downthrown side of the fault and blue is the upthrown side.

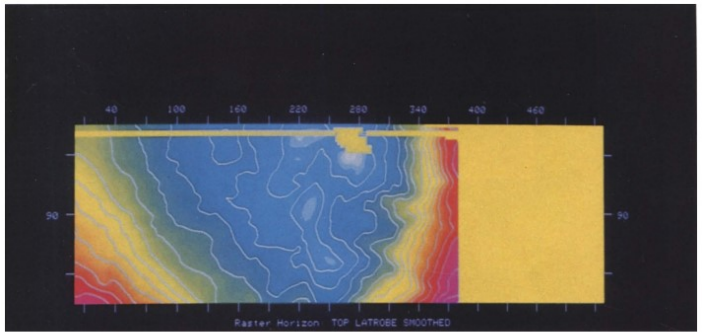


FIG. 5. The Top Latrobe horizon time map after applying a spatially square smoothing operator. The yellow blocks at the top of the map are where the horizon was not picked due to missing seismic data.

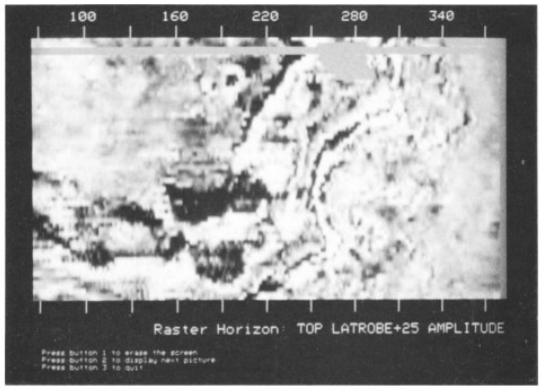
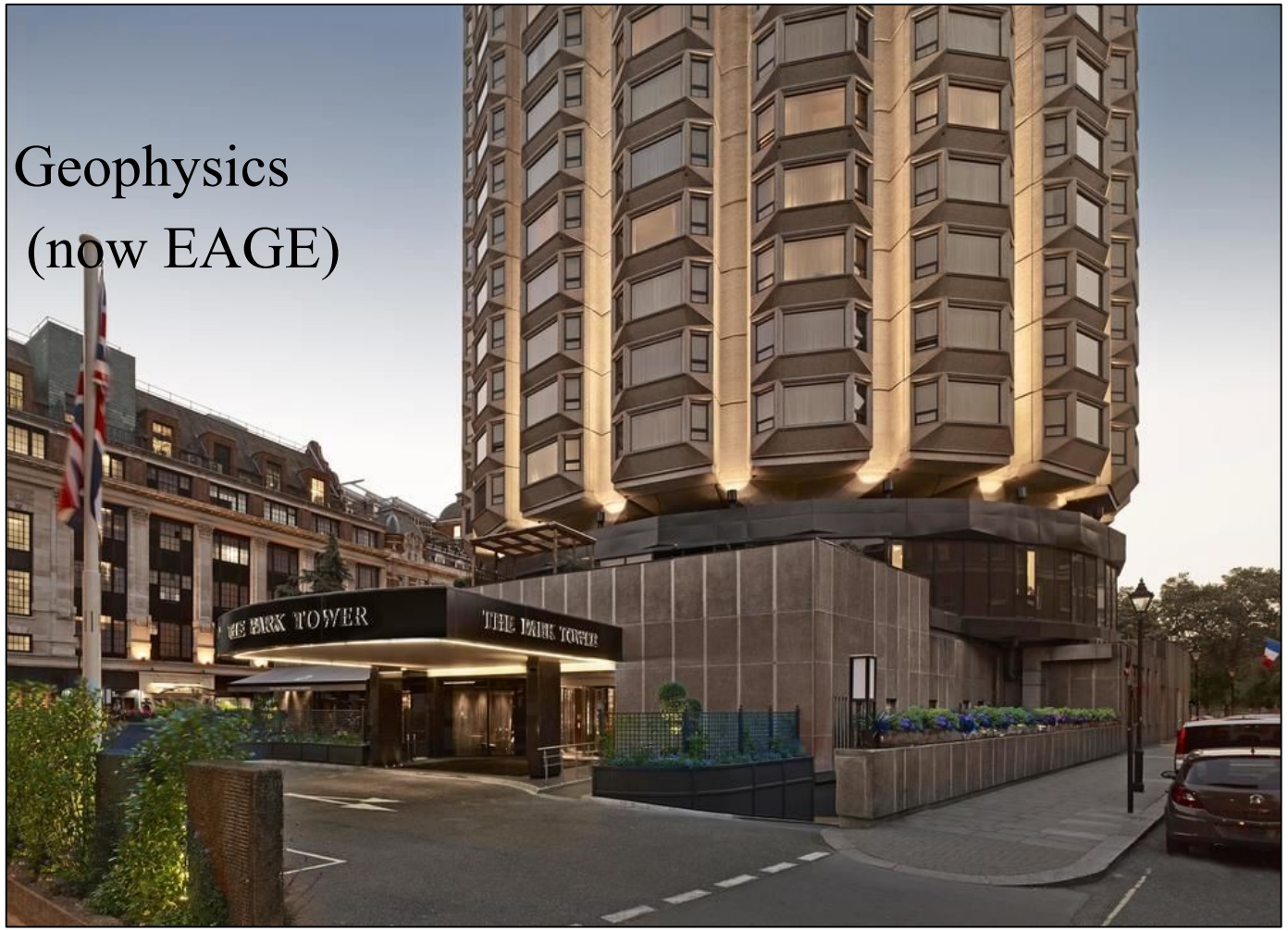


FIG. 10. A seismic amplitude extraction 25 ms below the Eocene unconformity. Compare this to Figure 2, and notice how well the geology is defined by the subcropping events.

1983-1993

28. IHRDC School

- New Technologies in Exploration Geophysics
- Following 1984 London EAEG (now EAGE)
- System from EAEG to Hotel
  - Intro
  - Shell Corporate vs Shell Expo
- From Hotel to Marathon Oil
- Sales call Conoco London
- Mobil Norway (Bob Peacock)
- Course Shell Ryswick, Holland
  - International Chief Geophysicists
  - Researchers, 21-25 Jan 1985

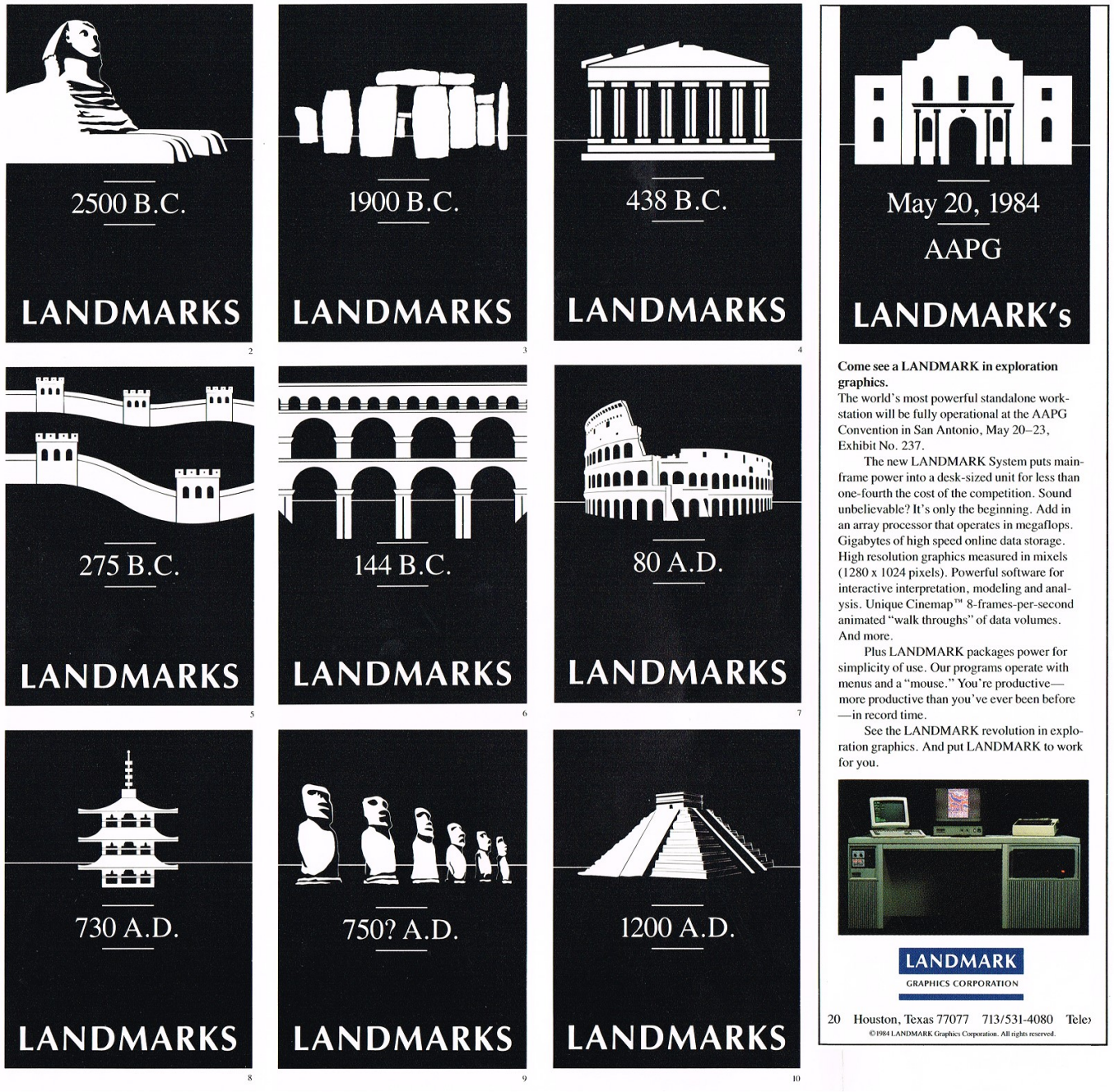


1983-1993

29. How do you summarize
    10 years of stories about
    all out plowing new fields?

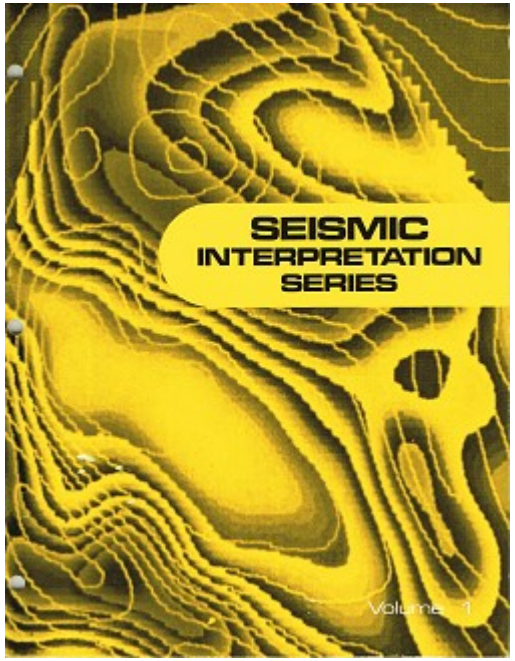
- From 2007 Resume:
  - 12 trips to Europe annually
  - 6 trips to Far East annually
  - 80 professional presentations
  - 22 schools: public, private,
  - 11 IHRDC schools
  - 8 SEG Research Workshops

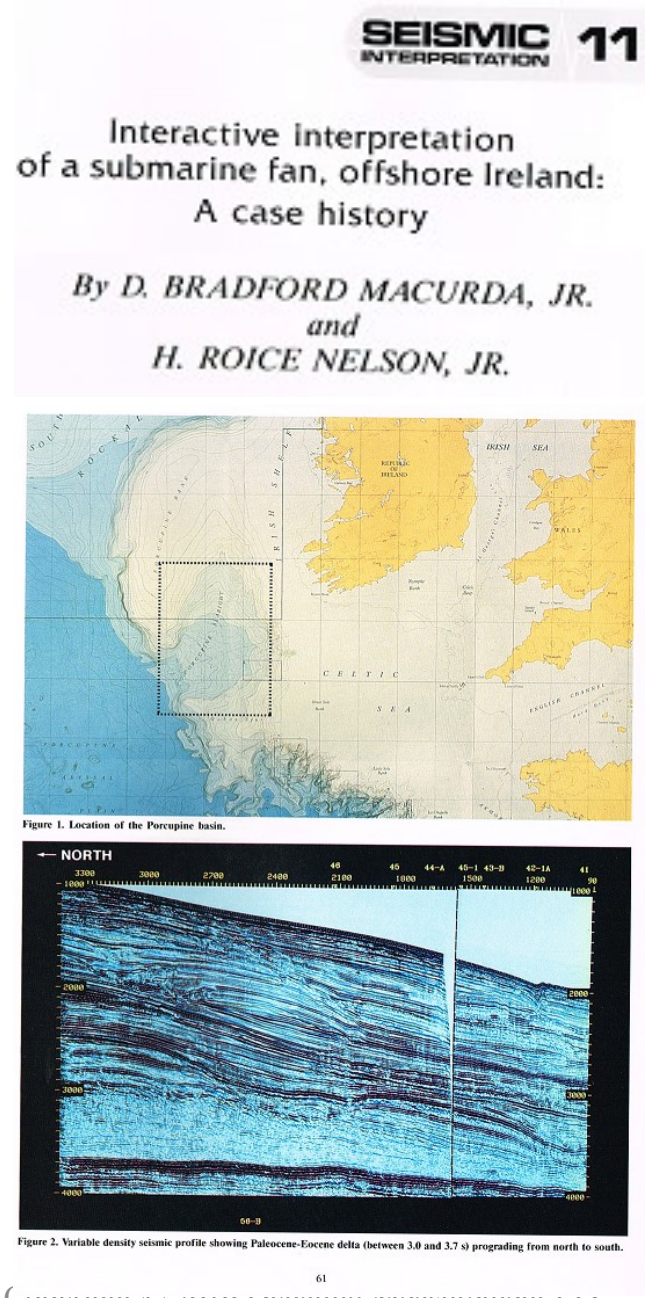
(http://www.walden3d.com/resumes/hrn.html)

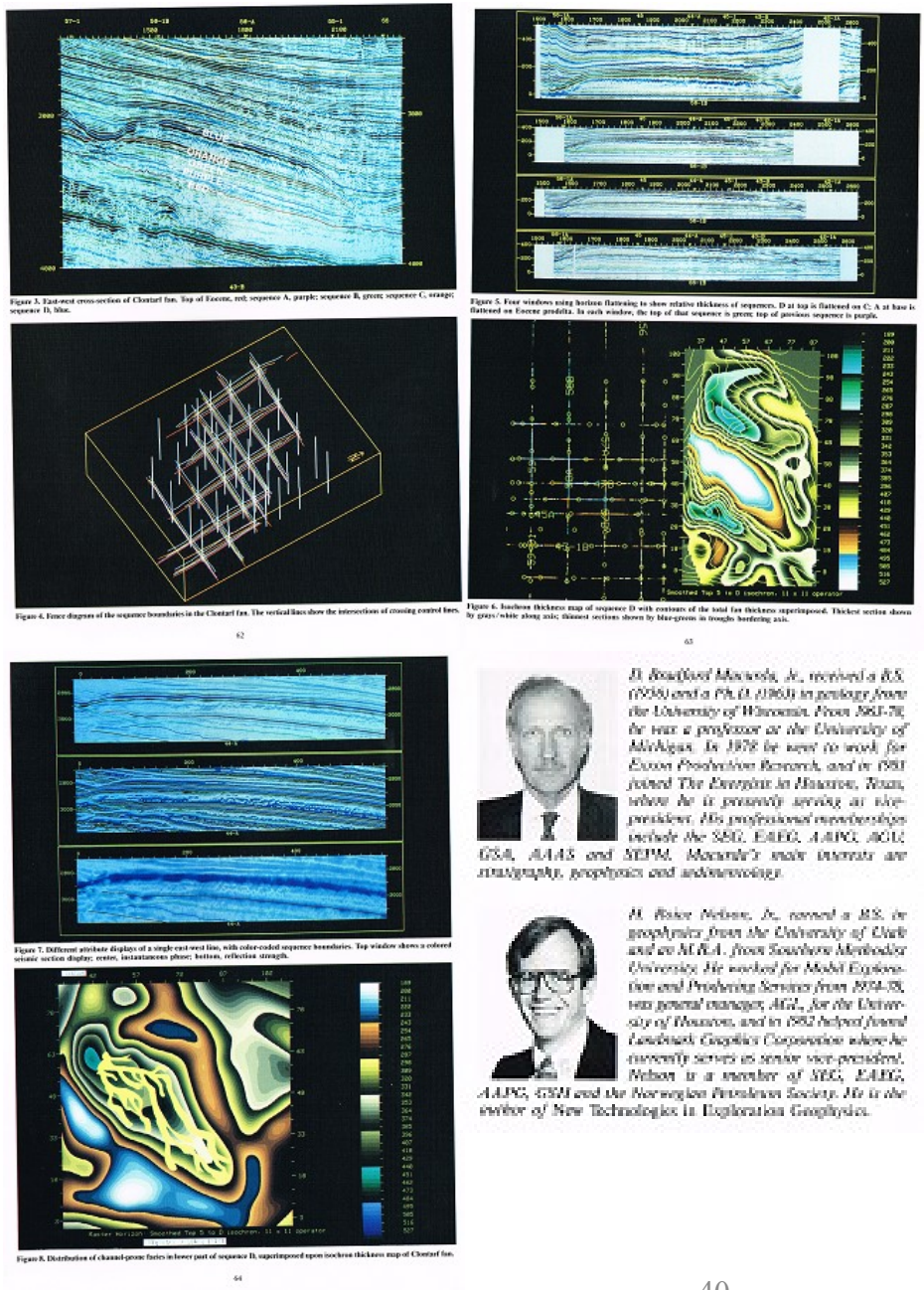


1983-1993

30. I enjoyed working on science with clients and making new finds.



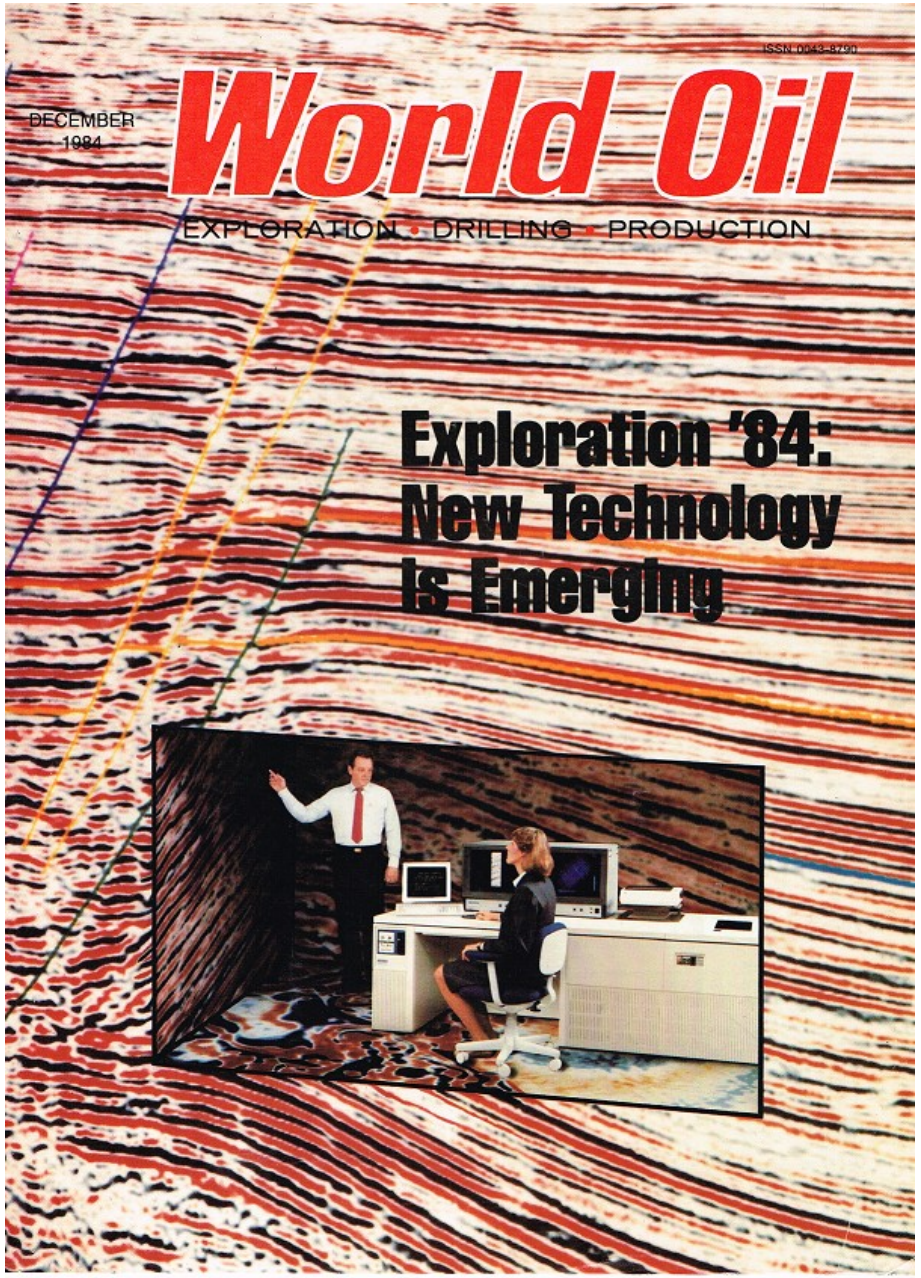




1983-1991

30. Bookends

- 1984 World Oil Cover
- 1991 O&G Journal Cover

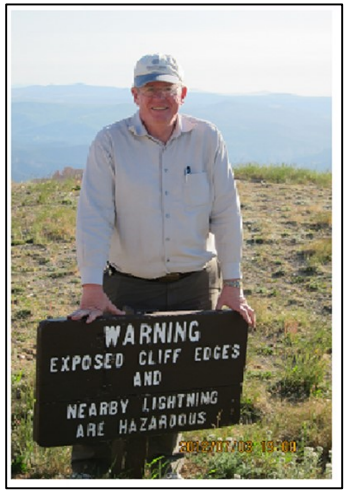


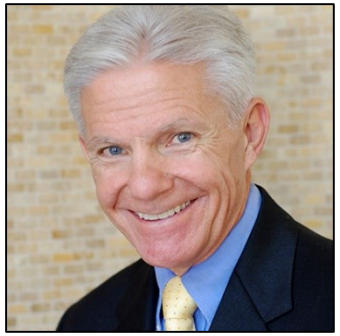
Workstations related operations started after 1993

- Global Basin Research Network (GBRN) – Dr. Roger Anderson
- HyperMedia Corporation – Andrew Dove & Alex Massad
- Advanced Structures Incorporated – Mic Patterson
- Virtual Environment Technology Lab (VETL) – Dr. Bowin Loftin
- Walden Visualization Systems – Johnny Amason
- Creative Enterprise Solutions – Albert Boulanger
- Continuum Resources International Corporation – Jeff Hume & Dave Monk
- V-Patch (Virtual Oil Patch) – Steve Joseph
- Dynamic Resources Corporation
- Dynamic Measurement LLC

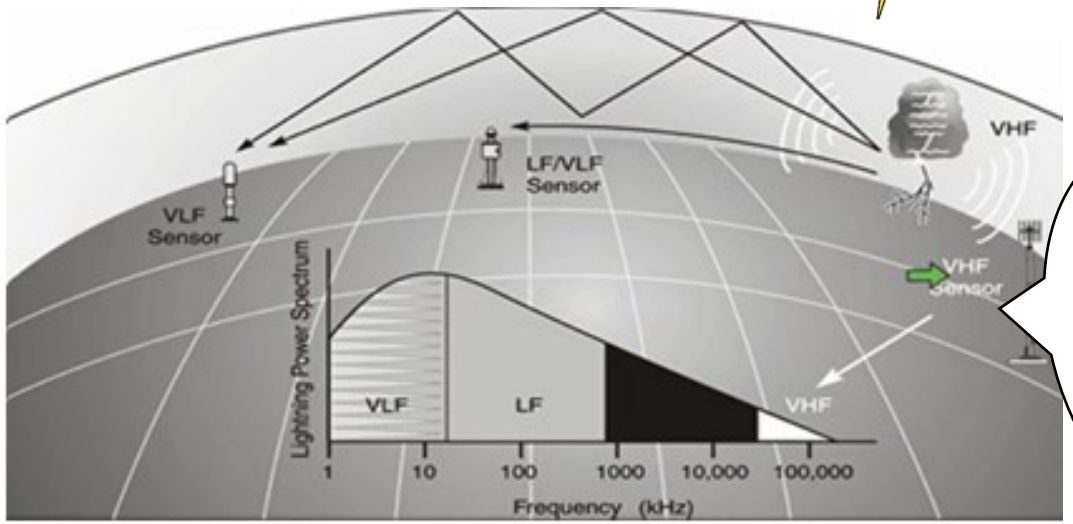
DYNAMIC MEASUREMENT

Dynamic Measurement LLC

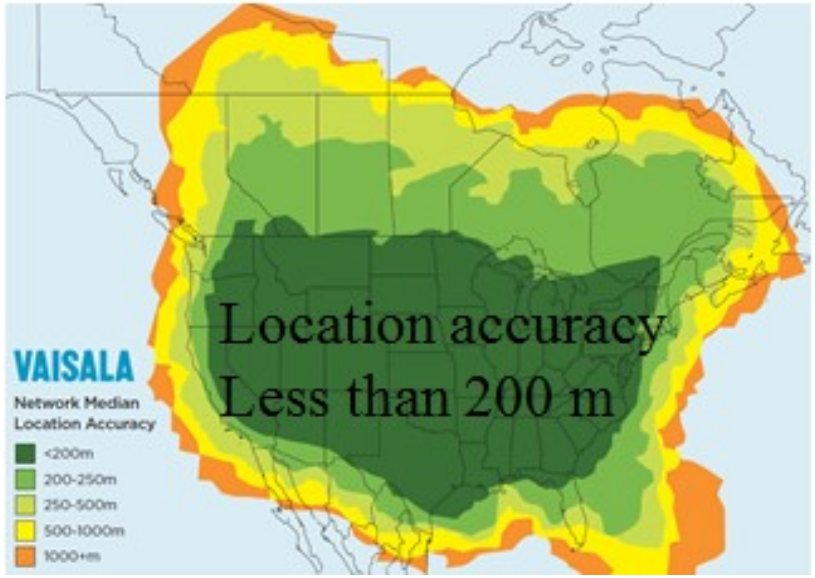


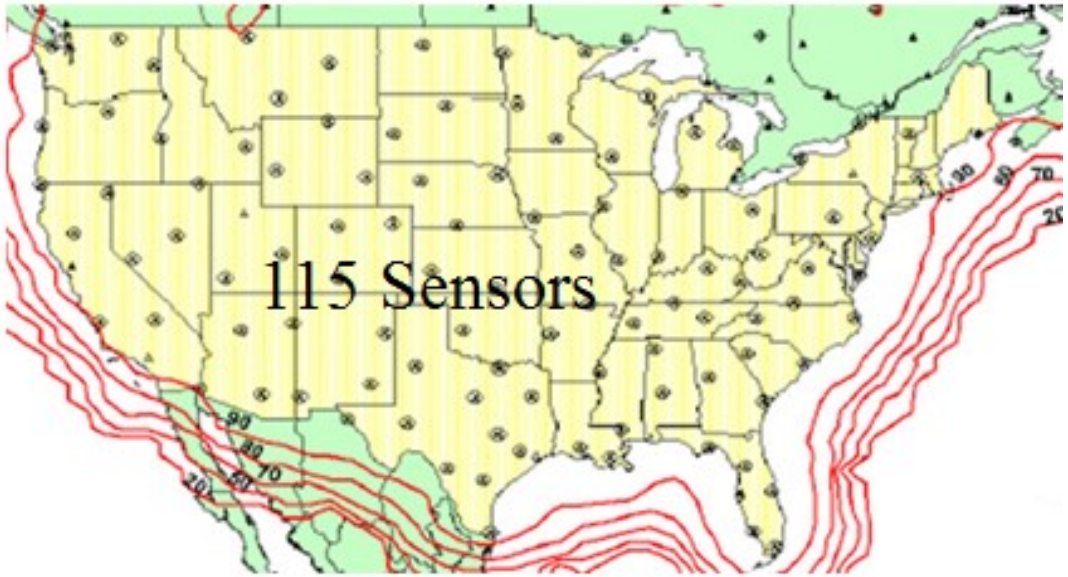


NLDN (National Lighting Detection Network)

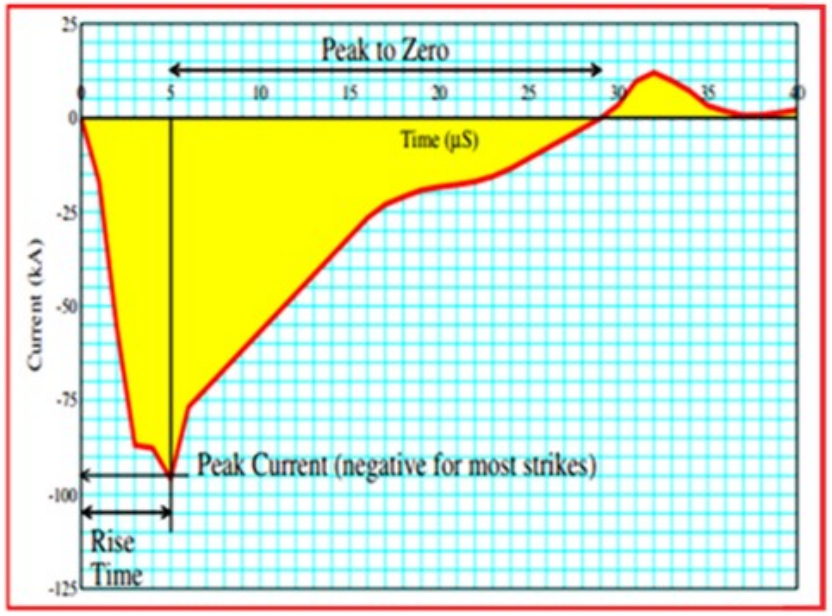


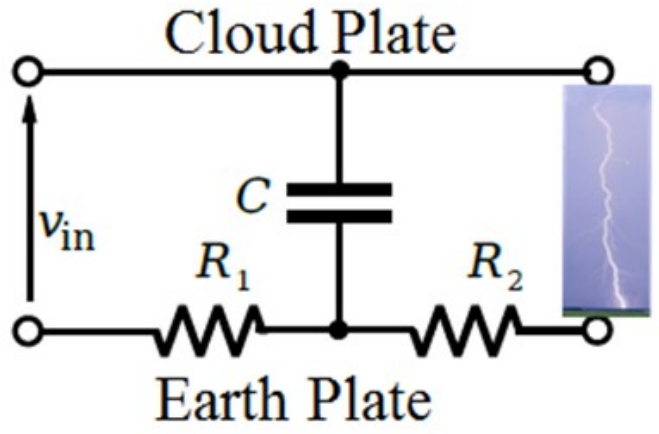
Hailing on all frequencies!



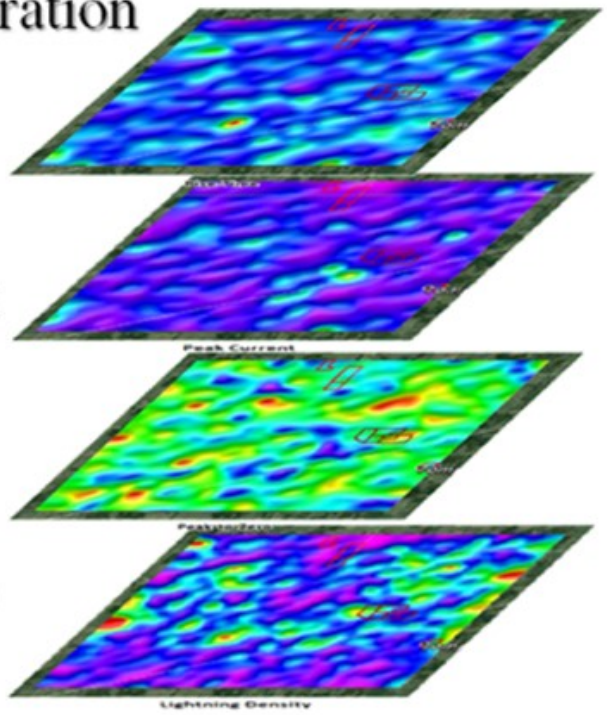


Lightning Analysis Data and Theory





- Location
- Time and Duration
- Rise Time
- Peak Current
- Polarity
- Peak-to-Zero
- Density



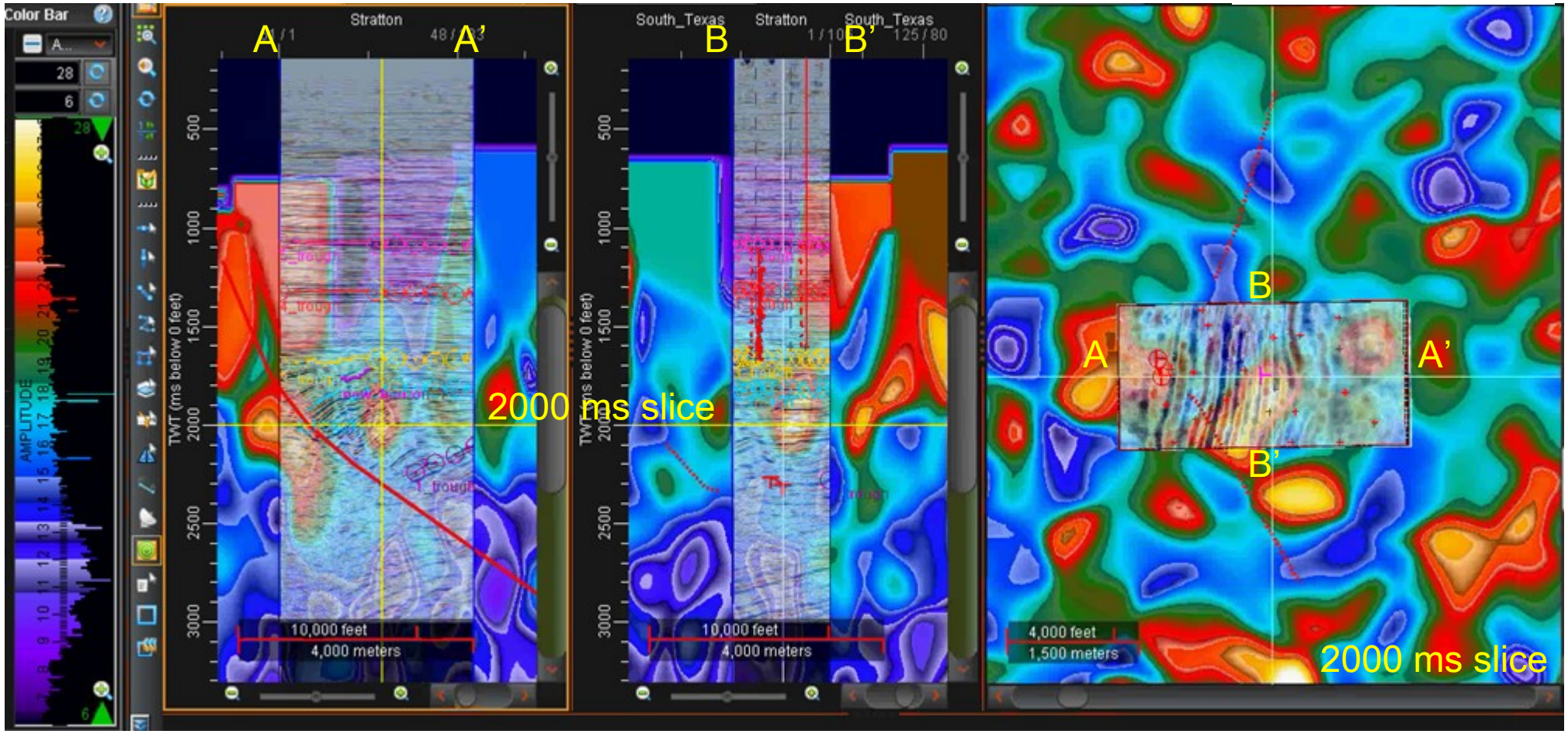
Calculated Rock Properties and Lightning Attribute Maps and Volumes

1. Density (Strikes per sq km [per year, sometimes over time span of the data set])
2. Day-of-Year (Decimal fraction calendar year. 00:00 on Jan 1 = 0.0, & 24:00 on Dec 31 = 1.0)
3. Energy ([pc * (rt + pz)/2] milliampere-seconds)
4. Frequency (kilohertz)
5. Moon Local Longitude (degrees [-180 to 180])
6. Moon Phase (degrees [0-360])
7. Peak-to-Zero (microseconds)
8. Absolute Peak Current Absolute (kiloamperes)
9. Apparent Permittivity (microfarads per meter)
10. Apparent Resistivity (ohm-meters)
11. Rise-Time (microseconds)
12. Spike (map position of strike, or calculated volume position of strike)
13. Sun Local Longitude (degrees [-180 to 180])
14. Symmetry (% [<50: rt<pz; 50: rt=pz; >50: rt>pz])
15. Tidal Gravity (microgals [+- relative to long term mean])
16. Tide (fraction of tidal range [-1.0: low spring tide; 0.0: mean tide; 1.0: high spring tide])
17. Tidal Gradient (first derivative of Tide)
18. Total Wavelet Time (microseconds)

Temporal variations of any of the above attributes (sorting data from time 1 to time 2)

BEG Stratton Calibration

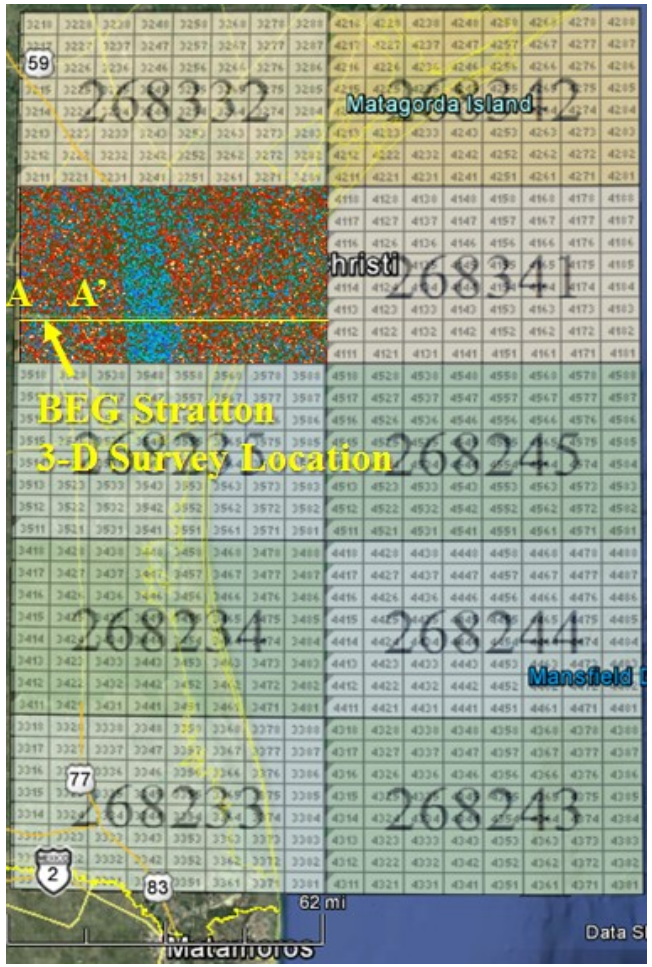
Lightning volumes can be overlaid on 2-D or 3-D seismic, like velocity analysis is, to identify trends and sweetspots

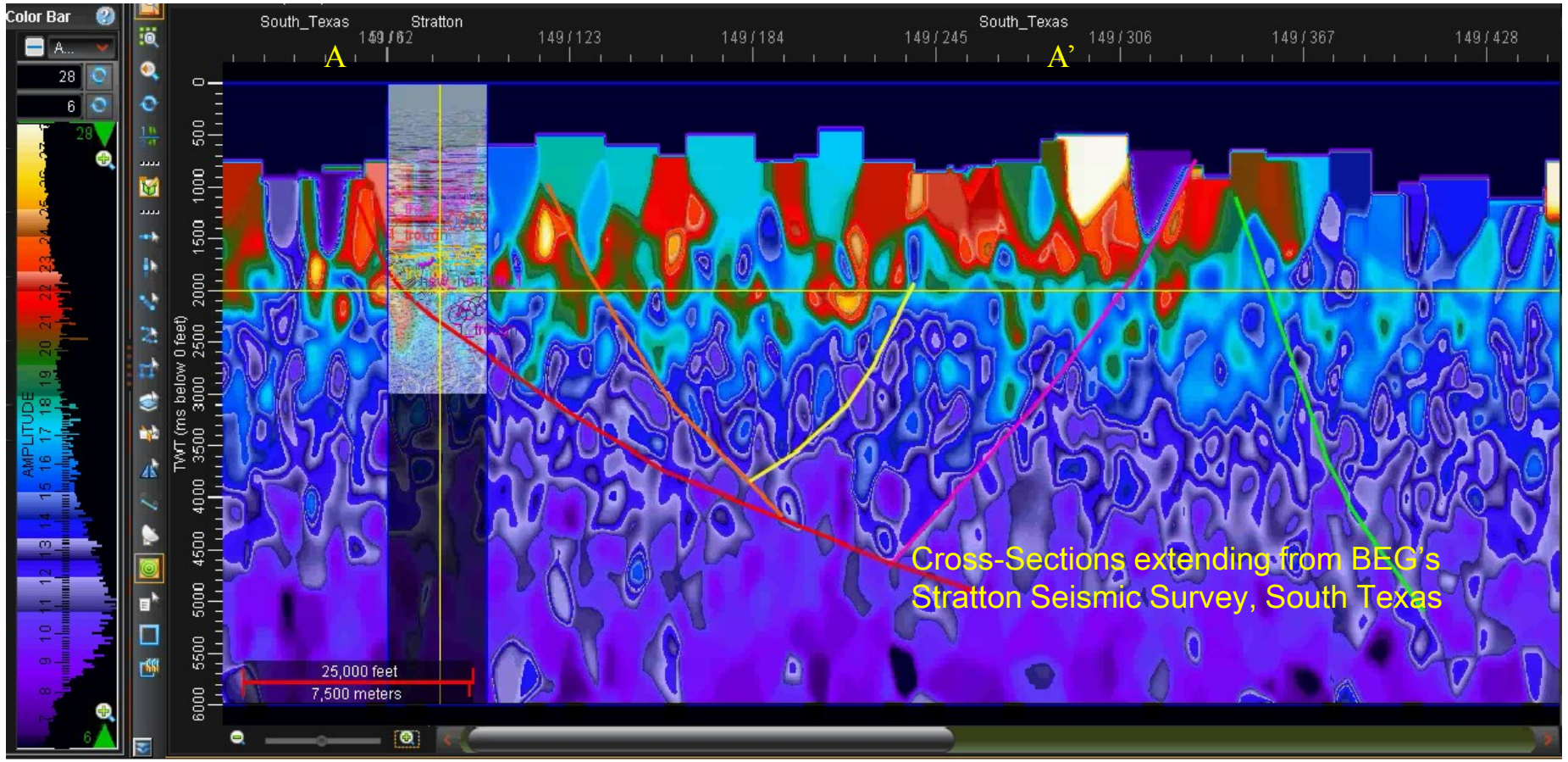


Stratton Apparent Resistivity In-Line Seismic Section Cross-Line Section Time-Slice Section

Cross-Sections across BEG's Stratton Seismic Survey, South Texas

Prospect or Regional Scale Evaluation

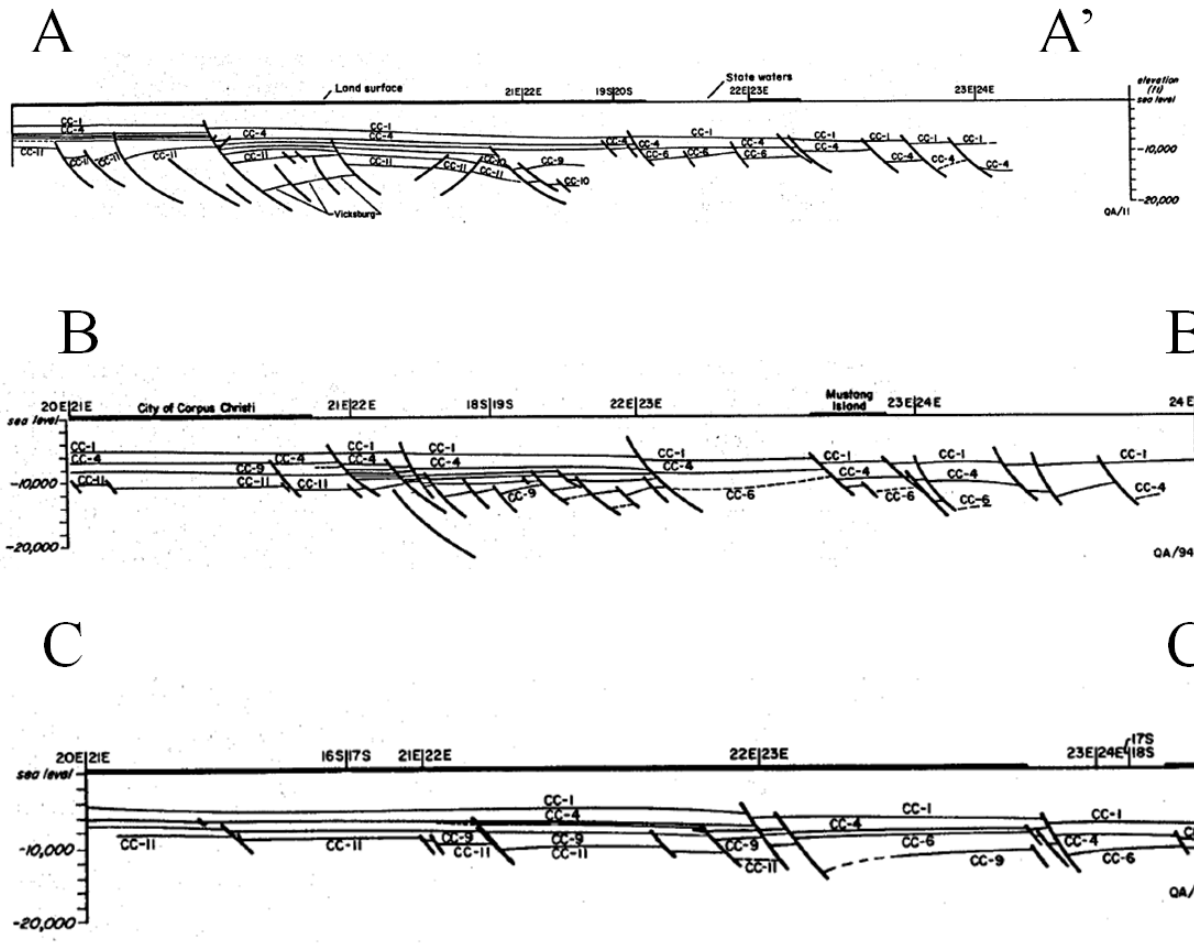


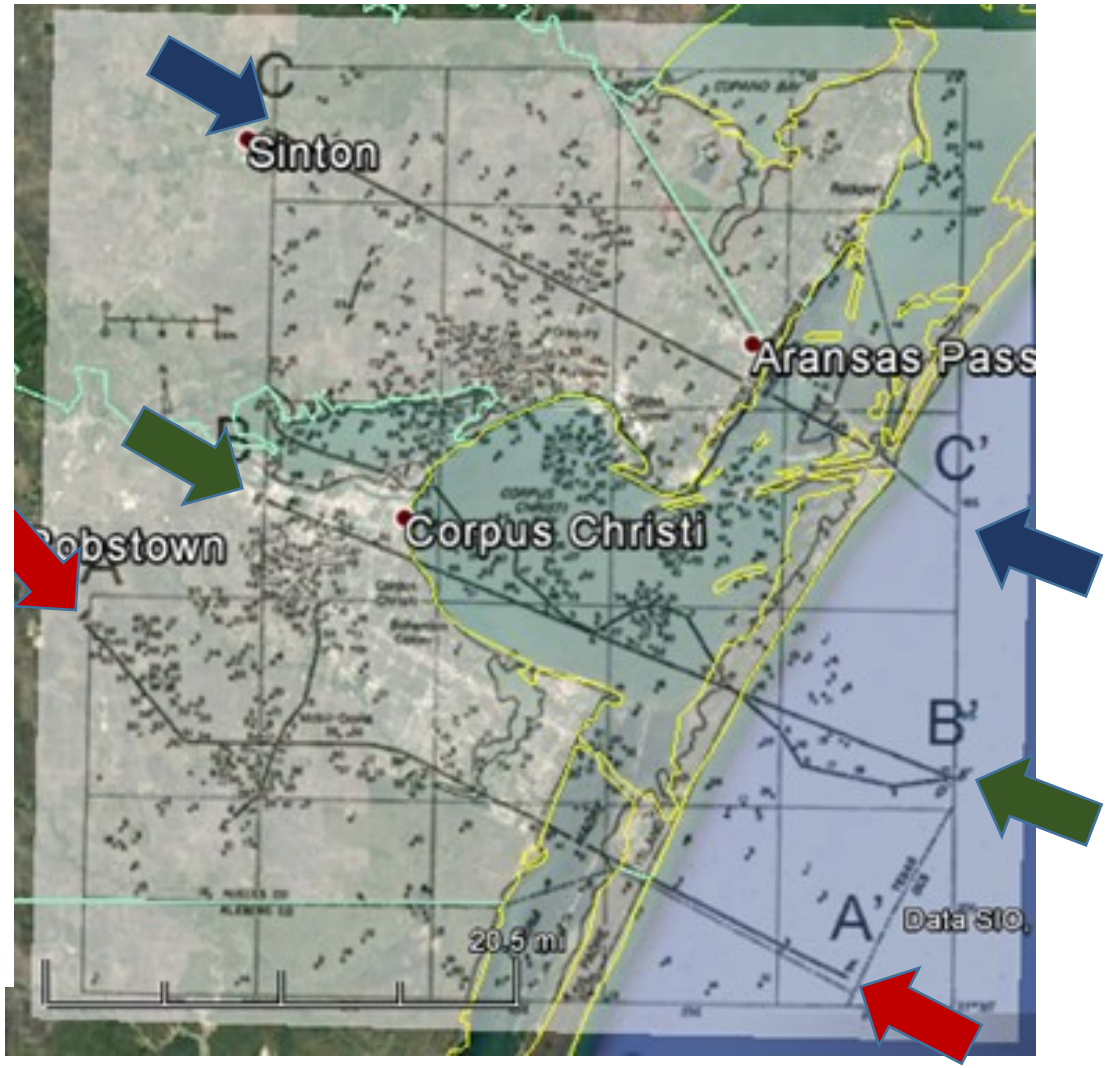


Cross-Sections

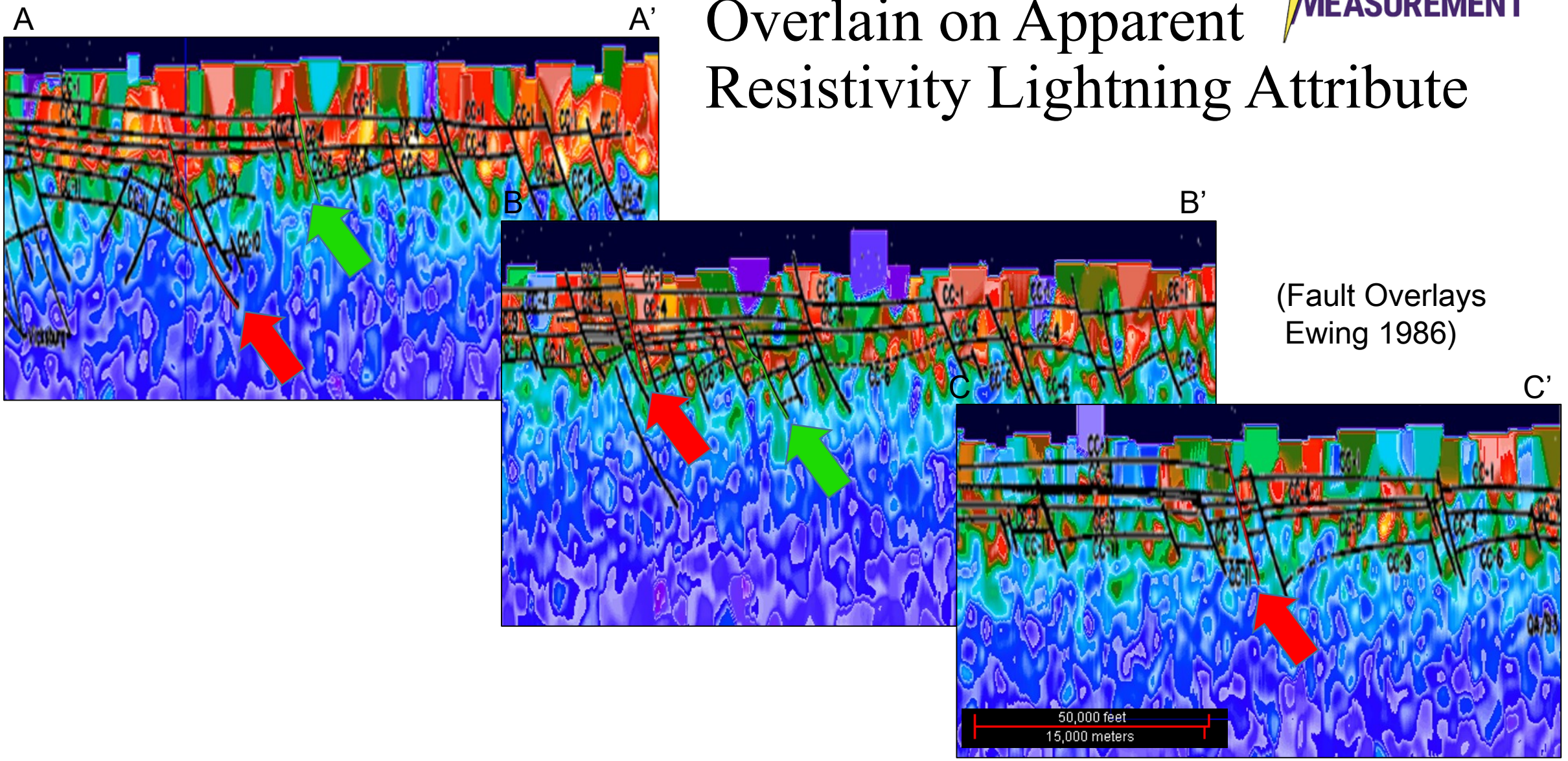
A-A’, B-B’, C-C’

Ewing, T,E., 1986, Structural Styles of the Wilcox and Frio Growth-Fault Trends in Texas: Constraints on Geopressured Reservoirs, BEG, Report of Investigations No. 154, pp.27-56.





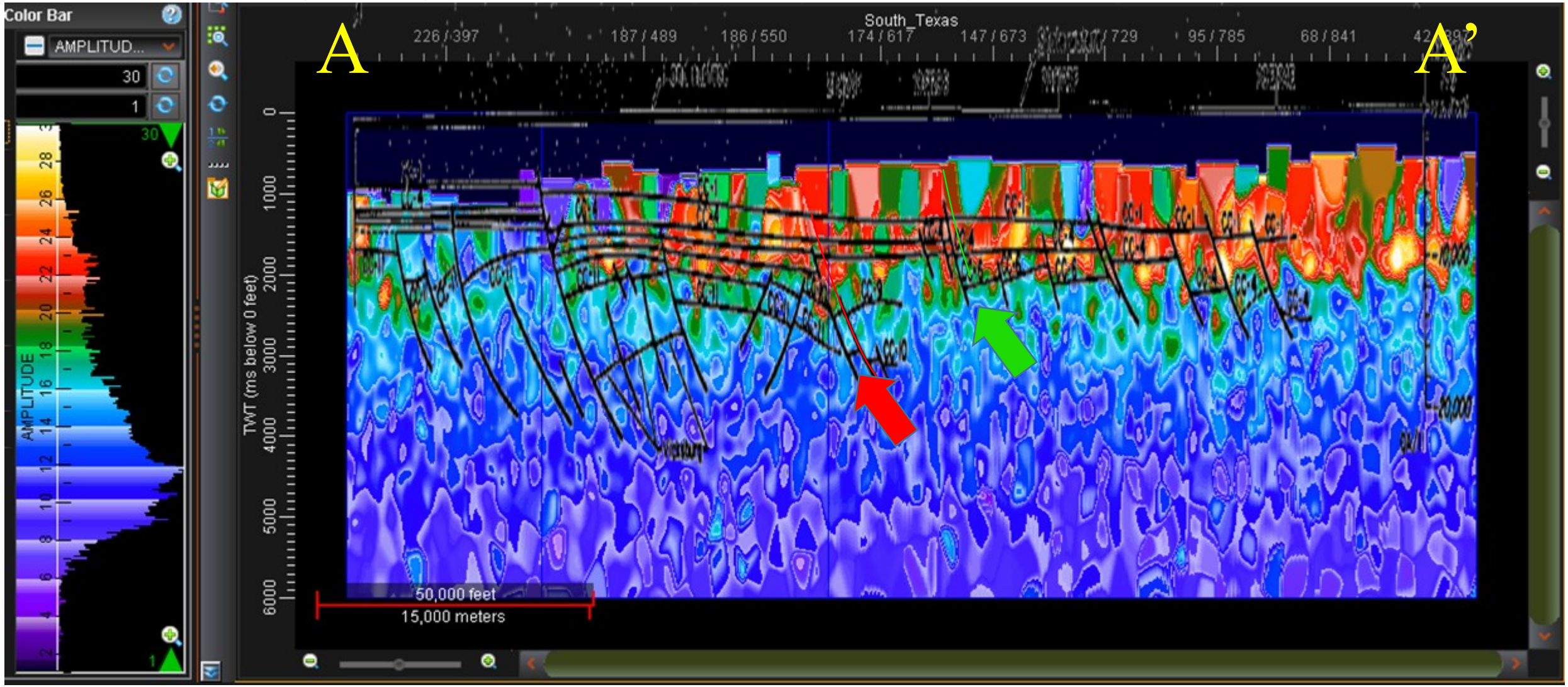
Overlain on Apparent Resistivity Lightning Attribute



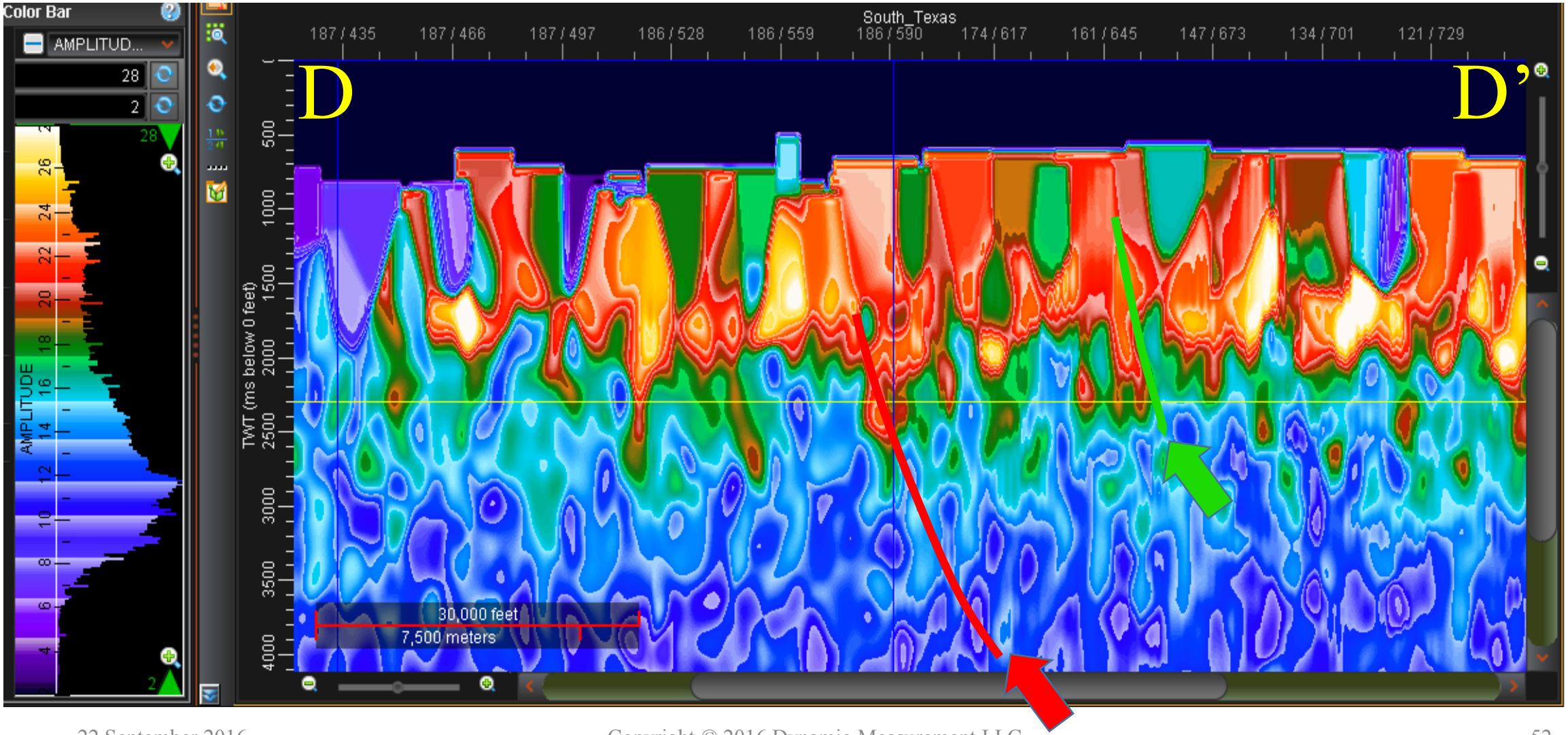
(Fault Overlays Ewing 1986)

Ewing (1986) Fault Cross-Section A-A’

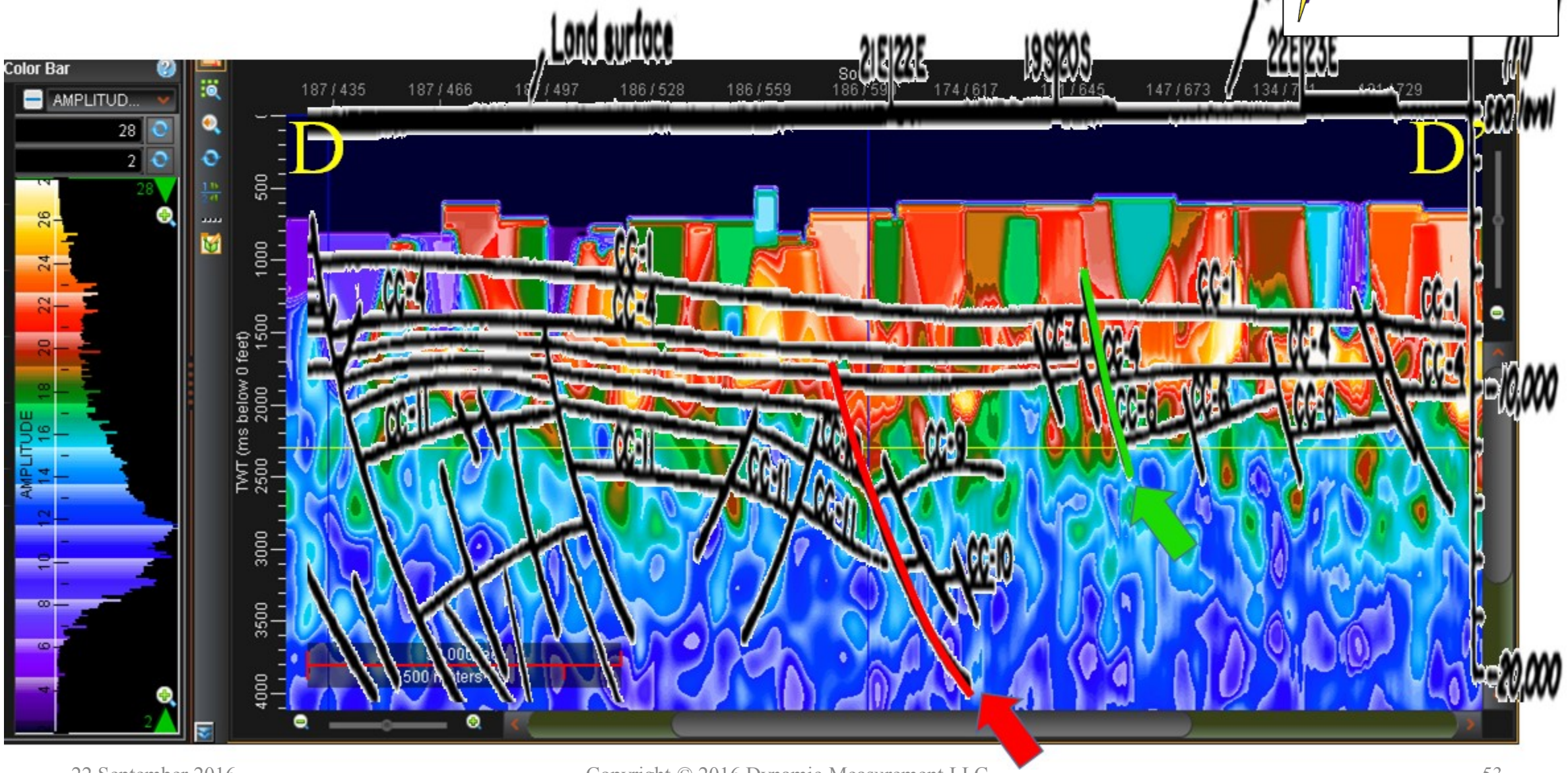
overlaid on lightning derived Apparent Resistivity volume



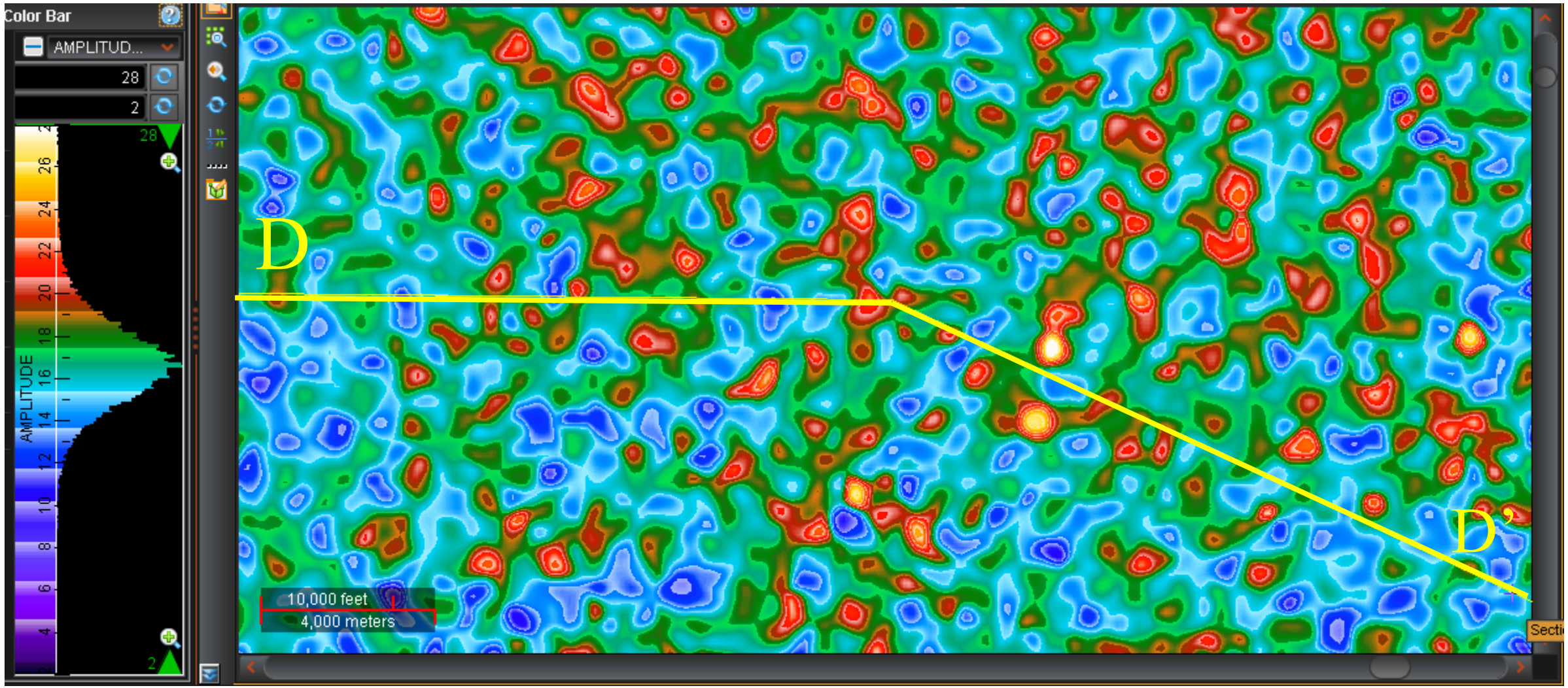
Close-Up on Graben to the west, without Overlay



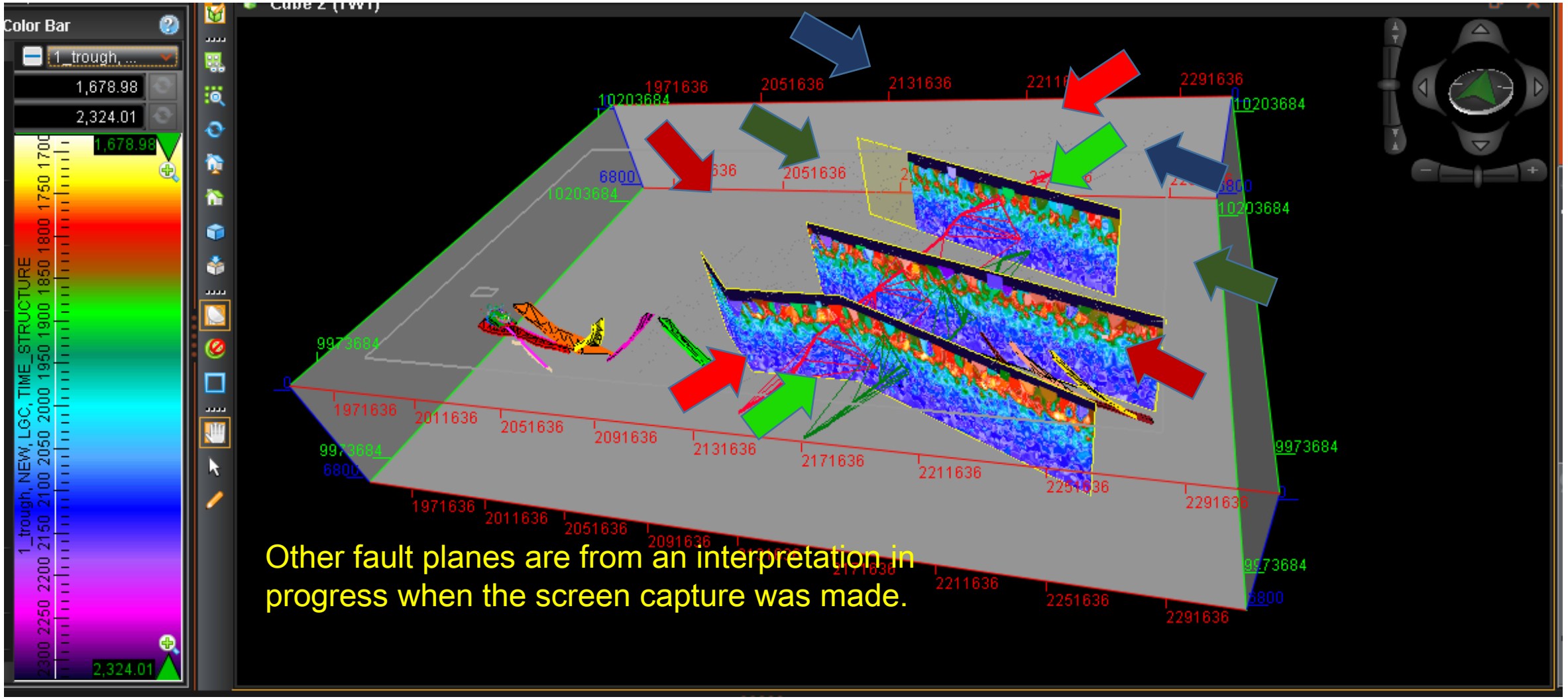
Close-Up on Graben to the west



Zoom on 2300 ms Time-Slice showing D-D’

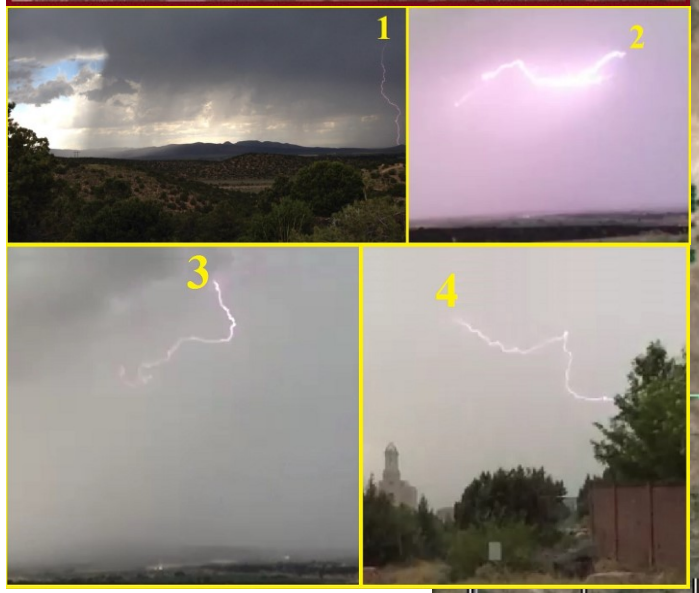


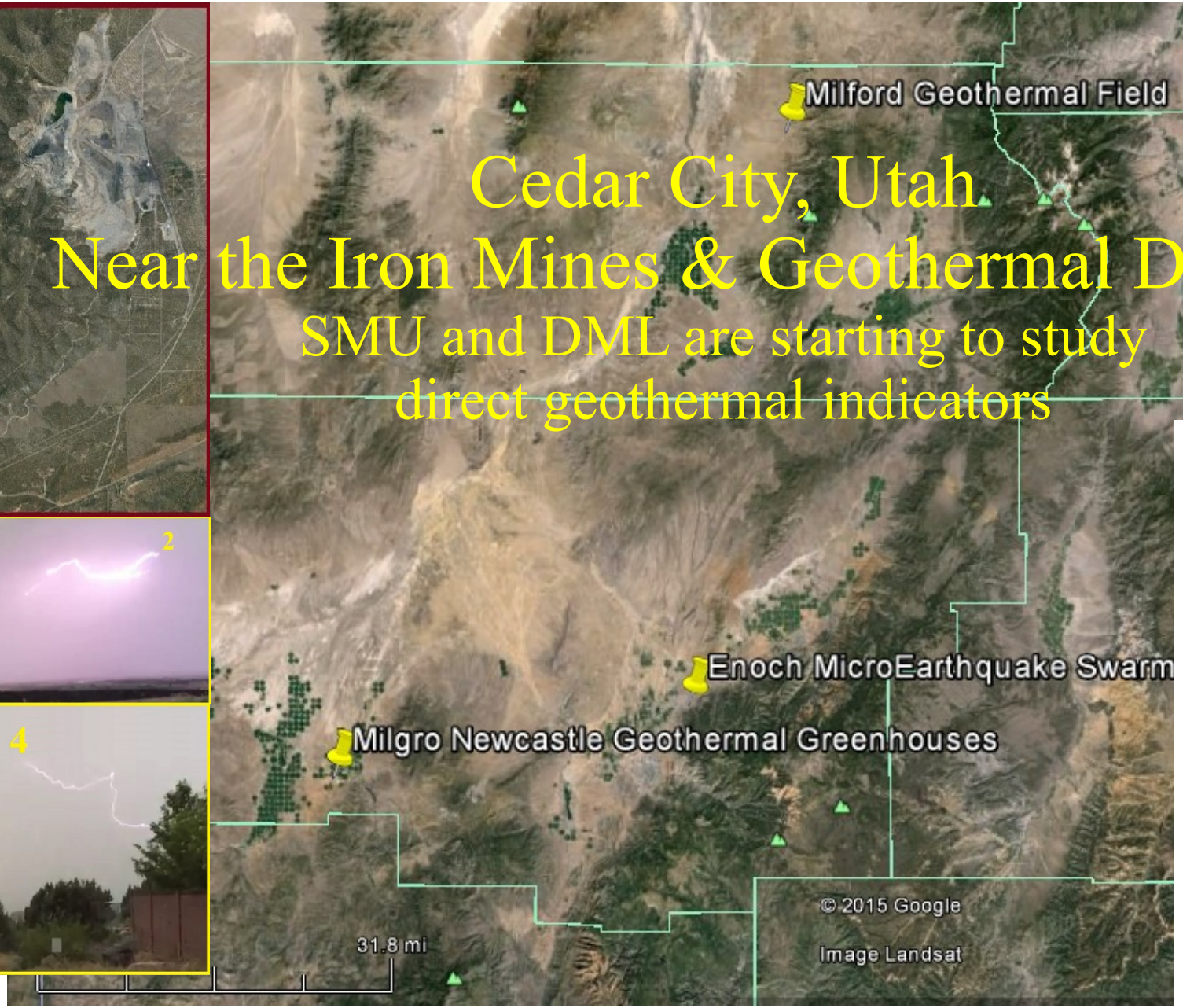
A-A', B-B', C-C' Cube Display



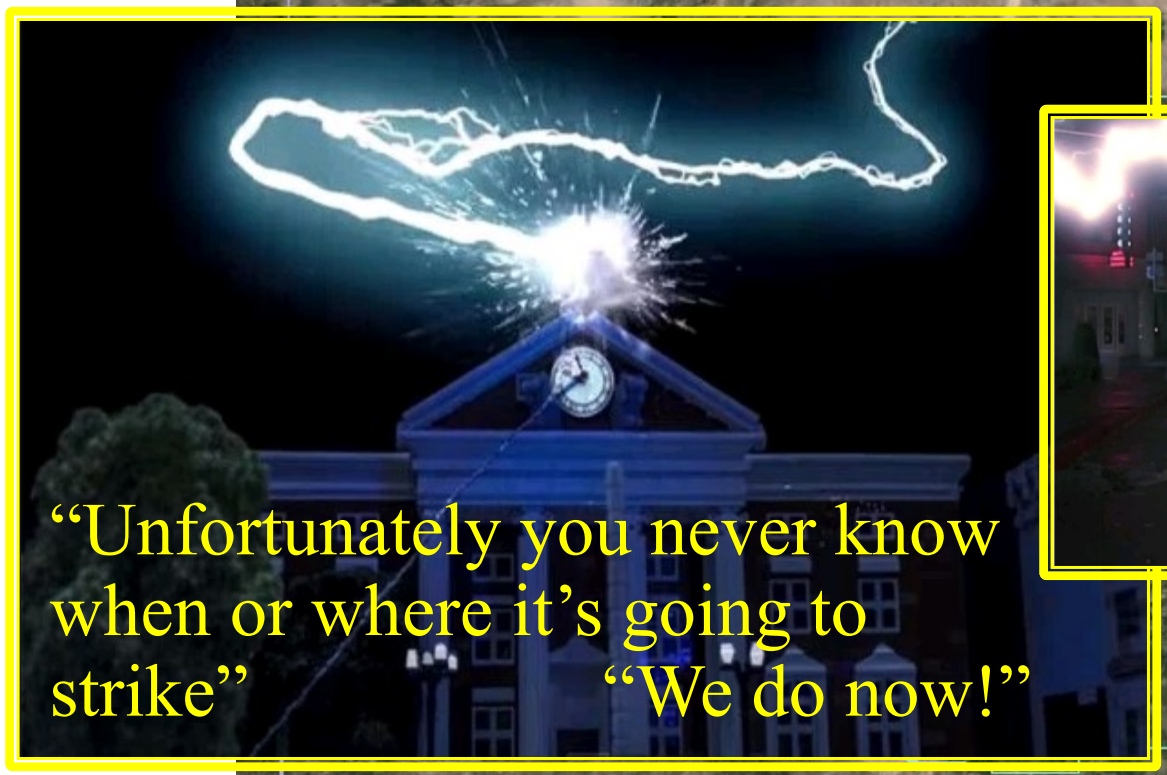
Cedar City, Utah
Near the Iron Mines & Geothermal Deposits

SMU and DML are starting to study direct geothermal indicators



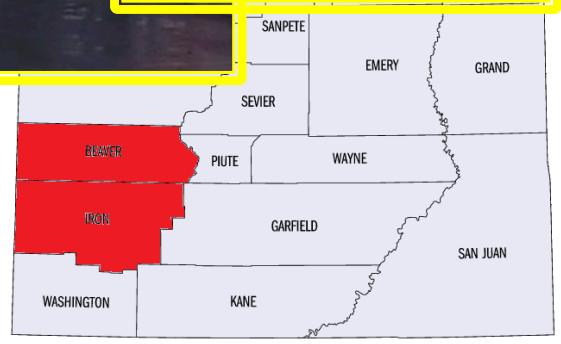


Great Scott, back to the future with a 1.21 "jigawatt" lightning bolt!



"Unfortunately you never know when or where it's going to strike"

"We do now!"



Thank You

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roice@dynamicmeasurement.com

These slides are posted at:
http://www.dynamicmeasurement.com/TAMU/160922_The_History_of_Seismic_Interpretation_Workstations.pdf