



Kinematics, Inc.

New Developments

Date: 23-24 February, 2012

Presented at: Antelope User Group Meeting

By: Ogie Kuraica, Vice President



This presentation would be impossible without ...

- IRIS (GSN, PASSCAL, DMC, EarthScope – USArray)
- UNAVCO (EarthScope – PBO)
- IGPP, UC San Diego
- University of Alaska, Fairbanks
- Caltech, Pasadena, California
- UC Berkeley , California
- UC Los Angeles , California
- UC Santa Barbara , California
- University of Nevada, Reno
- University of Colorado, Boulder
- Columbia University, Lamont-Doherty Earth Observatory
- USGS
- ORFEUS, Holland
- Geophone, Germany
- GeoScope IPGP, France
- ZAMG, Austria
- DPC, DST, OGS: Italy
- ARSO, Slovenia
- KMA, Korea
- ERI, University of Tokyo
- Malaysian TWS, Malaysia
- ERI/JAMSTEC, Japan
- KACST/KSU/KAU, Saudi Arabia
- SQU, Oman
- GeoScience, Australia
- GeoScience, Canada
-and especially those with limited budgets



Our Background:

Scientific Instrumentation, Application,
Manufacturing, and Service company

- ✦ Founded in 1969
- ✦ Headquarters, Pasadena, California - USA
- ✦ Headquarters, Quanterra, Harvard, Massachusetts – USA
- ✦ Headquarters, Metrozet, Los Angeles, California - USA
- ✦ Headquarters, BRTT, Boulder, Colorado - USA
- ✦ Headquarters, Streckeisen, Pfungen – Switzerland
- ✦ Office in Switzerland, Japan and Abu Dhabi
- ✦ Network Operation Services: 3
- ✦ Training Center: Pasadena, USA and ZAMG Vienna, Austria



Our Background cont.:

- ⊕ Network of over 60 representatives worldwide
- ⊕ Owned by OYO Corp. Japan, \$500M/Year Sales
- ⊕ 55+ Patents owned or applied by KMI & its sister group companies
- ⊕ More than 100,000 instruments installed worldwide
- ⊕ Leading Seismic Network and Service Company
- ⊕ Truly a Global Company....



Who We Are:

Company Confidential

Kinometrics, Inc.

- ✦ Large corporation with substantial financial resources
- ✦ World leader in the manufacture of strong motion seismic sensors and dataloggers
- ✦ Lots of experience in design, installation and supporting Open-Architecture System (OAS) networks for earthquake monitoring (i.e. seismic free field, structure, GPS and metrological) around the world
- ✦ Worldwide experience in network operation
- ✦ Fiscally strong with deep support and well developed corporate infrastructure (ISO 9001-2000 **Quality Control Management** in place to ensure they meet the needs of our customers)

Quanterra/Streckeisen, Inc.

- ✦ Data Acquisitions company:
- ✦ Designed **world's 1st** digital very broadband seismograph in early 80'
- ✦ Designed **world's 1st** true 24-bit seismic data acquisition system in early 80' s
- ✦ Designed **world's 1st** ultra low power 24-bit seismic data acquisition system in early 00' s
- ✦ Designed **world's 1st** true 26-bit seismic data acquisition system in 2005.
- ✦ Excellent worldwide reputation in the manufacture of ultra-high resolution dataloggers and very broadband seismometer for weak motion seismology



Who We Are cont.:

Company Confidential

Streckeisen, Pfungen – Switzerland

- The Sensor company
- Designed **world's 1st** digital Very Broad-Band (VBB) seismograph in early 80'
- STS 2.5 **world's best performance** Broad-Band (BB) seismometer
- Excellent worldwide reputation in the design and manufacture of Very Broad-Band (VBB) and Broad-Band seismometer (BB) for weak motion seismology

Metrozet, Los Angeles, California – USA

- “The Sensor Company”
- New company, established in late 2005’ ; principals worked for NASA (JPL) on the space missions seismometers, Schlumberger...
- With NSF funding, successfully designed the NEXT generation of original Streckeisen STS-1 design, the M2166-VBB **world's 2nd** Very Broadband seismometer (VBB) in early in 2010. **Result:** Improved the next generation of original Streckeisen STS-1 design, the M2166-VBB. Currently, the **world's best** performance seismometer
- Building worldwide reputation in the design and manufacture of Very Broadband (VBB), Broadband seismometer (BB) and Strong Motion (SM) accelerometers for weak and strong motion seismology

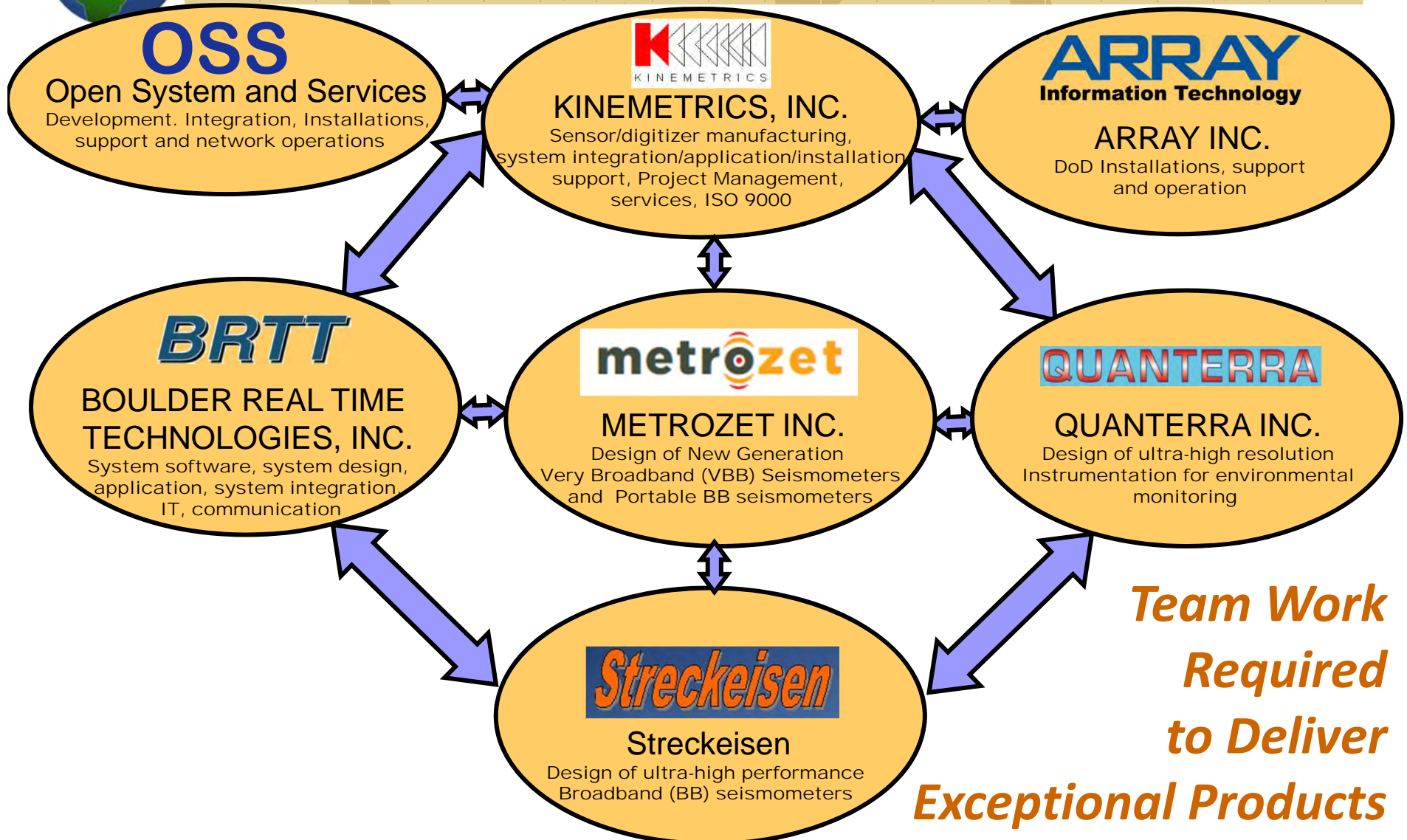
Boulder Real Time Technologies, Inc., Colorado, – USA

- Software company
- **World's largest** commercial seismic network software provider
- Designed one of the **world's first** digital seismic networks (UCSD-Anza, early 80's)
- Lots of software engineering experience, modern digital communication, information system experience, of operational experience



“inseparable right and left wheels”

Company Confidential





Branding Strategies and Focus

Premium Brands:

- ⊕ Quanterra/Streckeisen
 - VBB and BB digitizer/sensor company
- ⊕ BRTT
 - The Software company
- ⊕ Metrozet Sensors
 - The Sensor Company

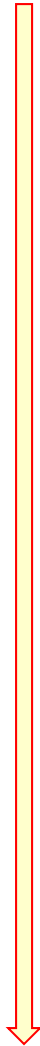
High Quality Brand:

- ⊕ Kinematics
 - Strong Motion and Data Acquisition Company

Cost Effective Brand:

- ⊕ EQMet
 - Competition: i.e. Reftek, Guralp, GeoSig, SysCom

Price



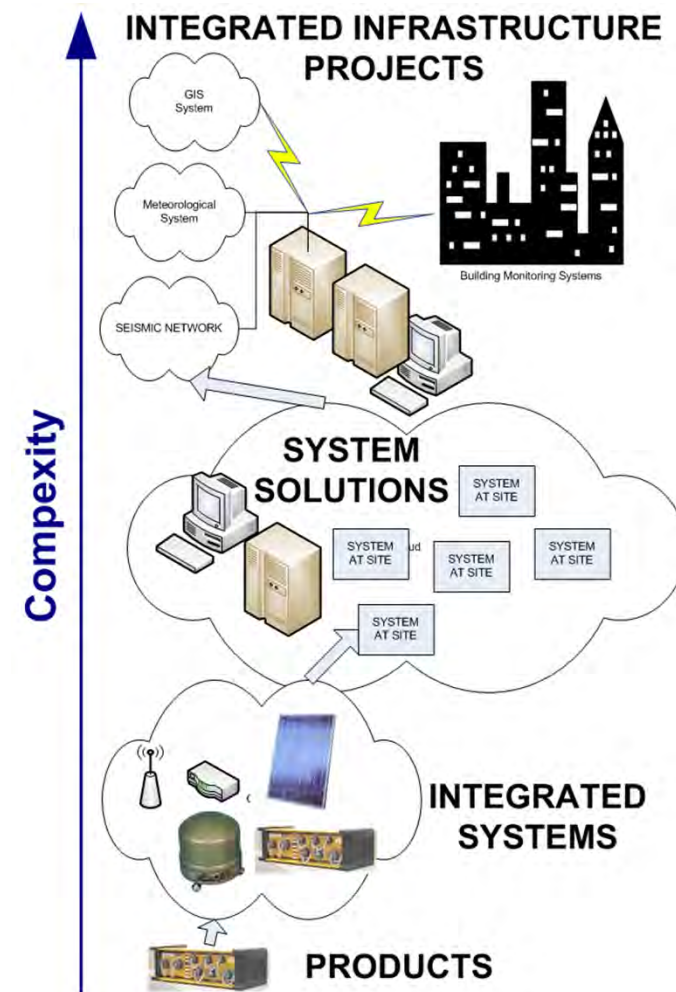


Complexity Driven Community of Users:

As equipment complexity increases, end-users are in need of NOT only Products but also of *Solutions* to solve their challenges:

Complexity increases with Time

- ✦ Products
- ✦ Integrated Systems
 - Deployment System (Sensor, Digitizer, Power & Communications)
- ✦ System Solution Projects
 - Building Systems
 - Nuclear Power Plants
 - Critical Lifelines
 - Regional & National Seismic Networks
 - Other Sensors
- ✦ Integrated Infrastructure Projects
 - i.e. City of Abu Dhabi project, ARAMCO etc.





Complexity Driven Market Offerings:

❖ KMI Offerings:

❖ COTS Products:

- Q330, Basalt, STS-2, PBB-200S etc..

❖ Open System and Services (OSS) Delivers:

❖ Seismic Monitoring Networks

- Regional & National Seismic Networks
- Infrasound
- OBS
- GPS
- Customization

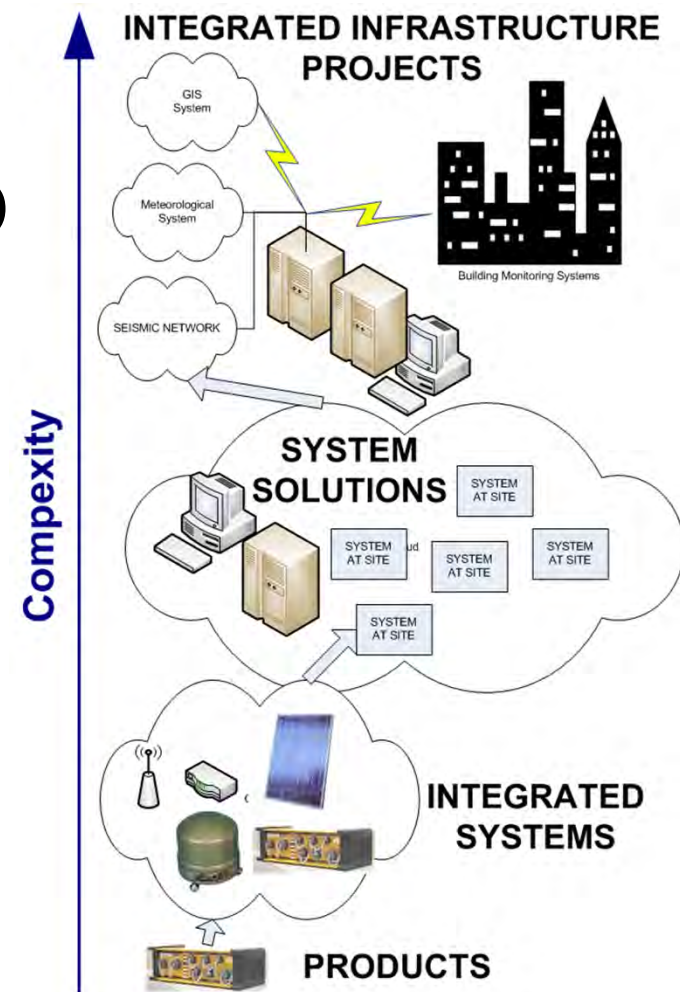
❖ Structure Monitoring Solutions

- Building Systems
- Structure Health Monitoring
 - Acceleration
 - GPS
 - Displacement
 - Strain
 - Wind, Temp. Humidity
 - Corrosion
 - Etc.

- Nuclear Power Plants
- Critical Lifelines
- Customization

❖ Operation, Maintenance and Support

❖ Since 1995 (Saudi Arabia project)





What Makes KMI a Unique Organization in our Community:

- ❖ Understanding of Application
 - Work in multi-disciplinary field:
 - Seismic (VBB, BB, SM, Nuclear)
 - SHO
 - OBS
 - GPS,
 - Engineering Services
- ❖ We are ONLY commercial company in our community that operate Seismic Networks
 - OTHER companies are equipment manufacturers
- ❖ Exceptional level of education of work force
 - 10+ PhD
 - Average employment 15+ years
- ❖ Quality Control: ISO 9001-2000
- ❖ Parent Company: OYO Corporation financial support



What Makes KMI a Unique Organization in our Community cont.:

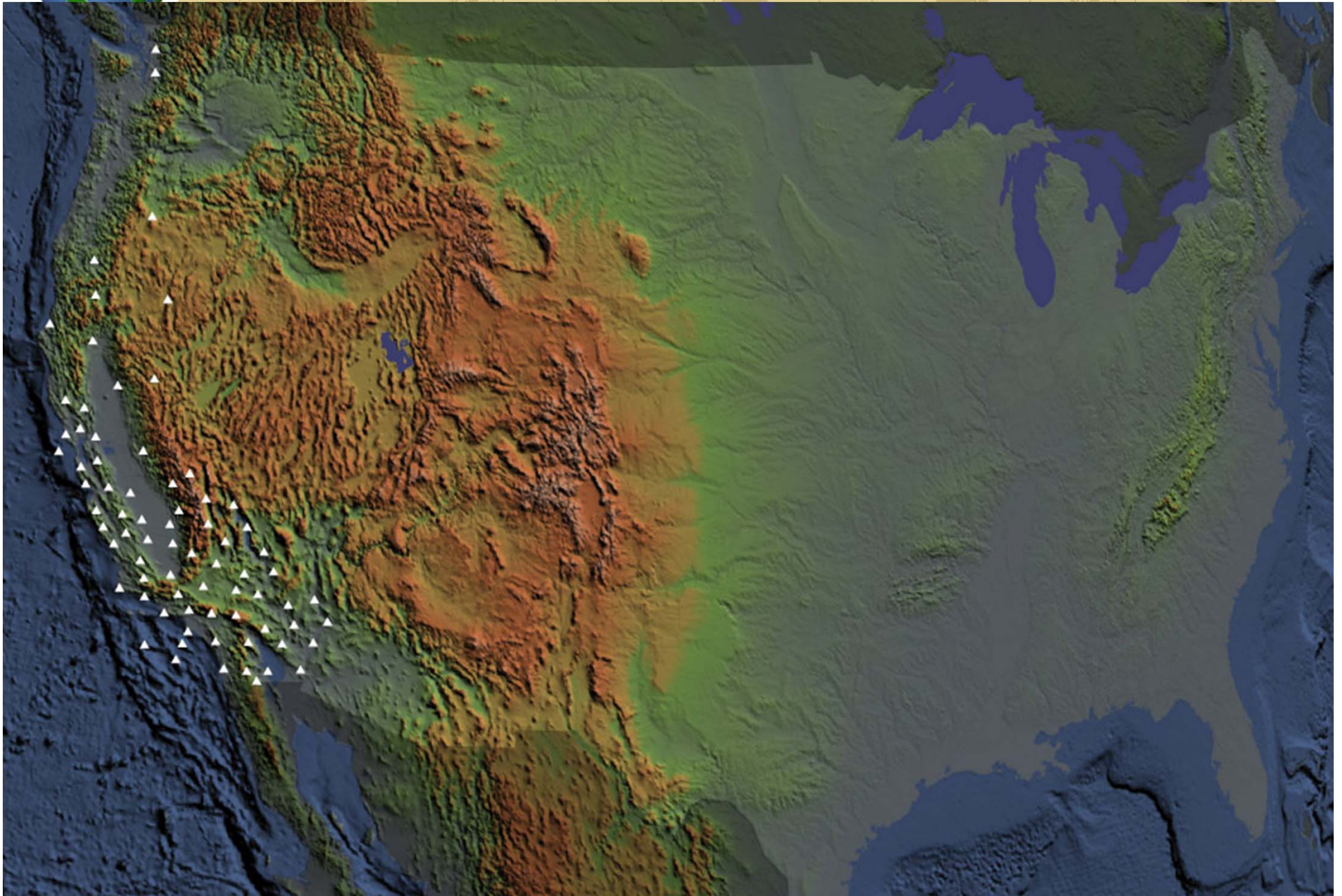
✦ **Since 2005:**

- We won ALL major projects:
 - USArray: \$15M
 - GSN: \$5M
 - ANSS: \$12M
 - Abu Dhabi: \$30M
 - Chile: \$8M



USArray: 2005

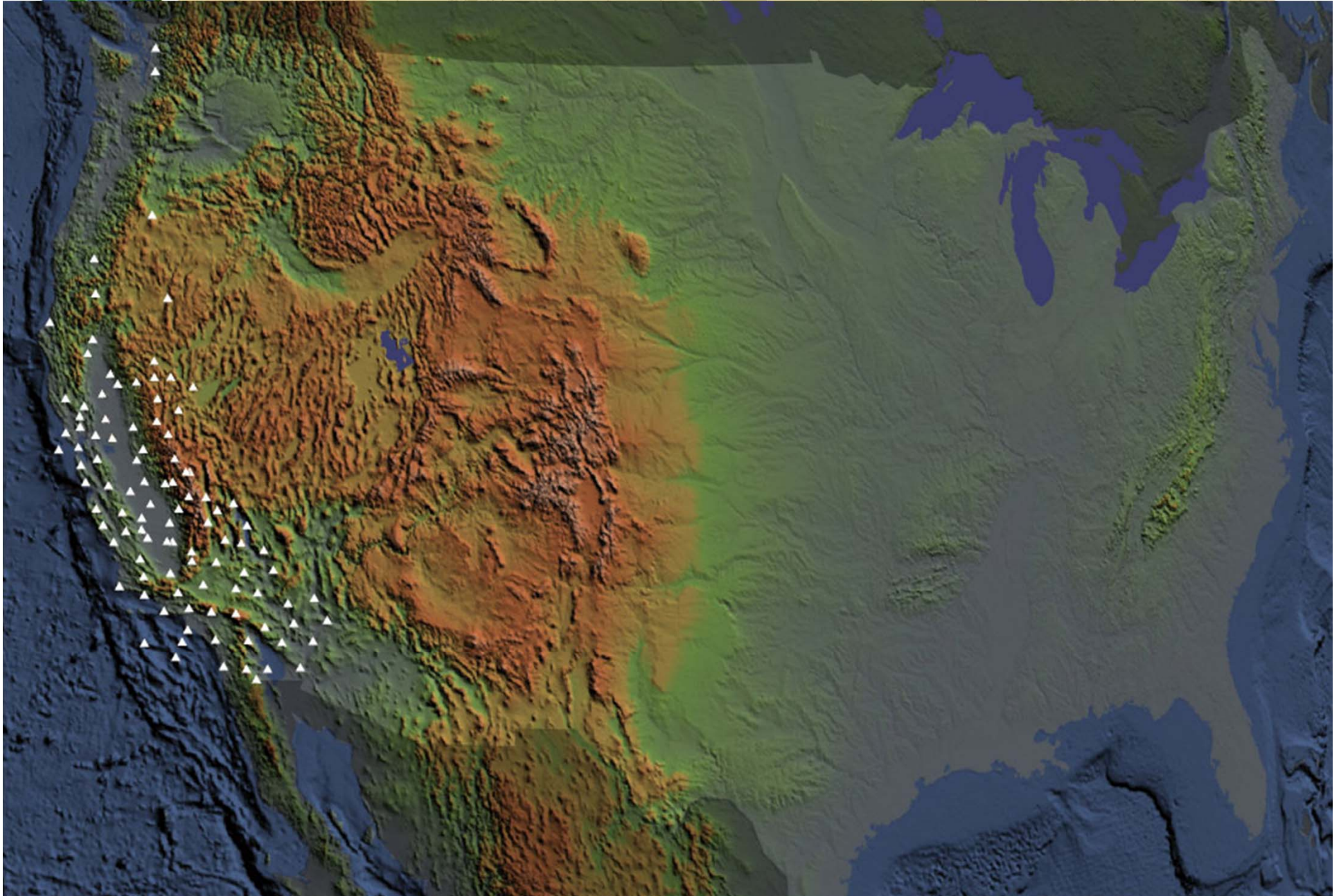
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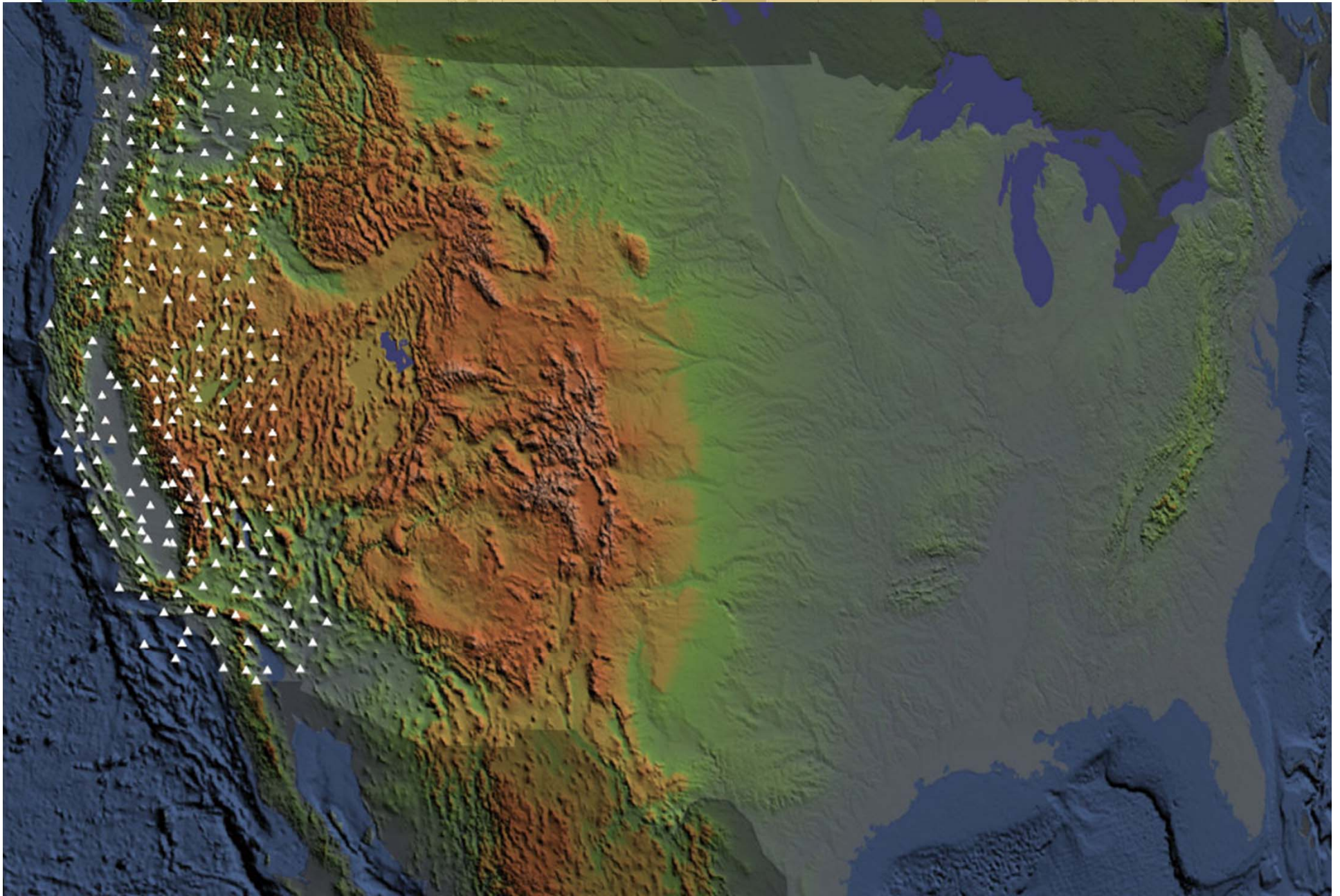
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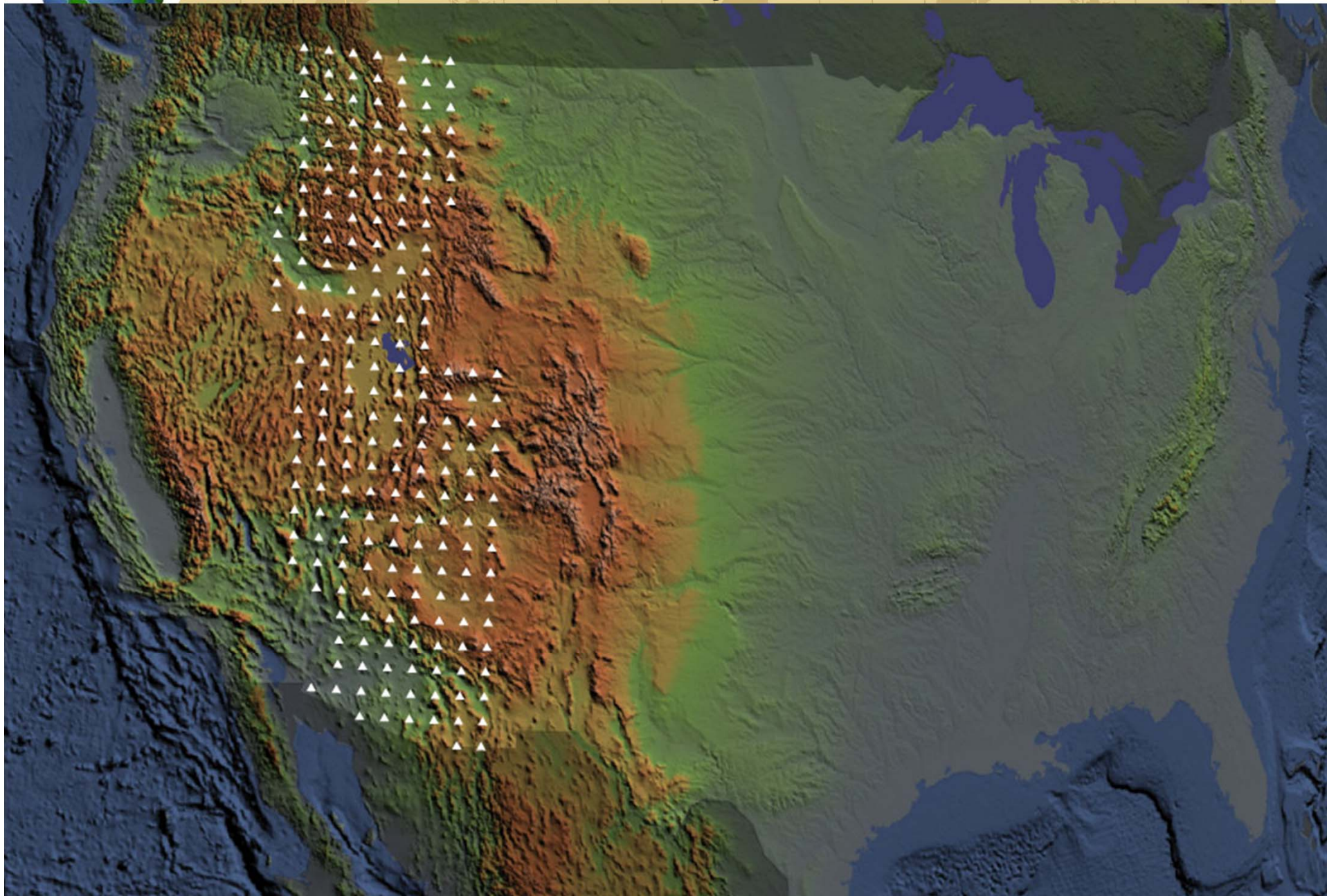
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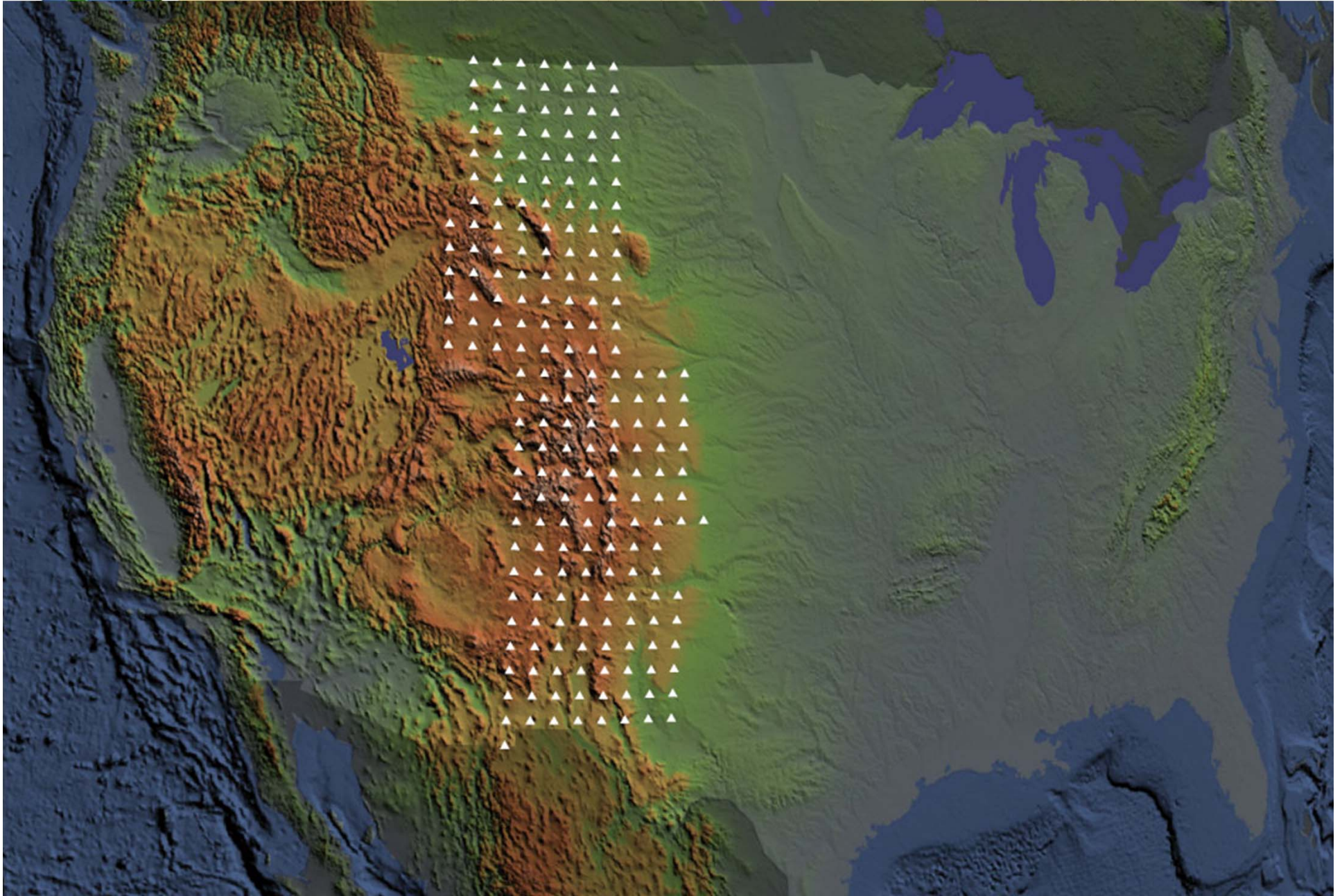
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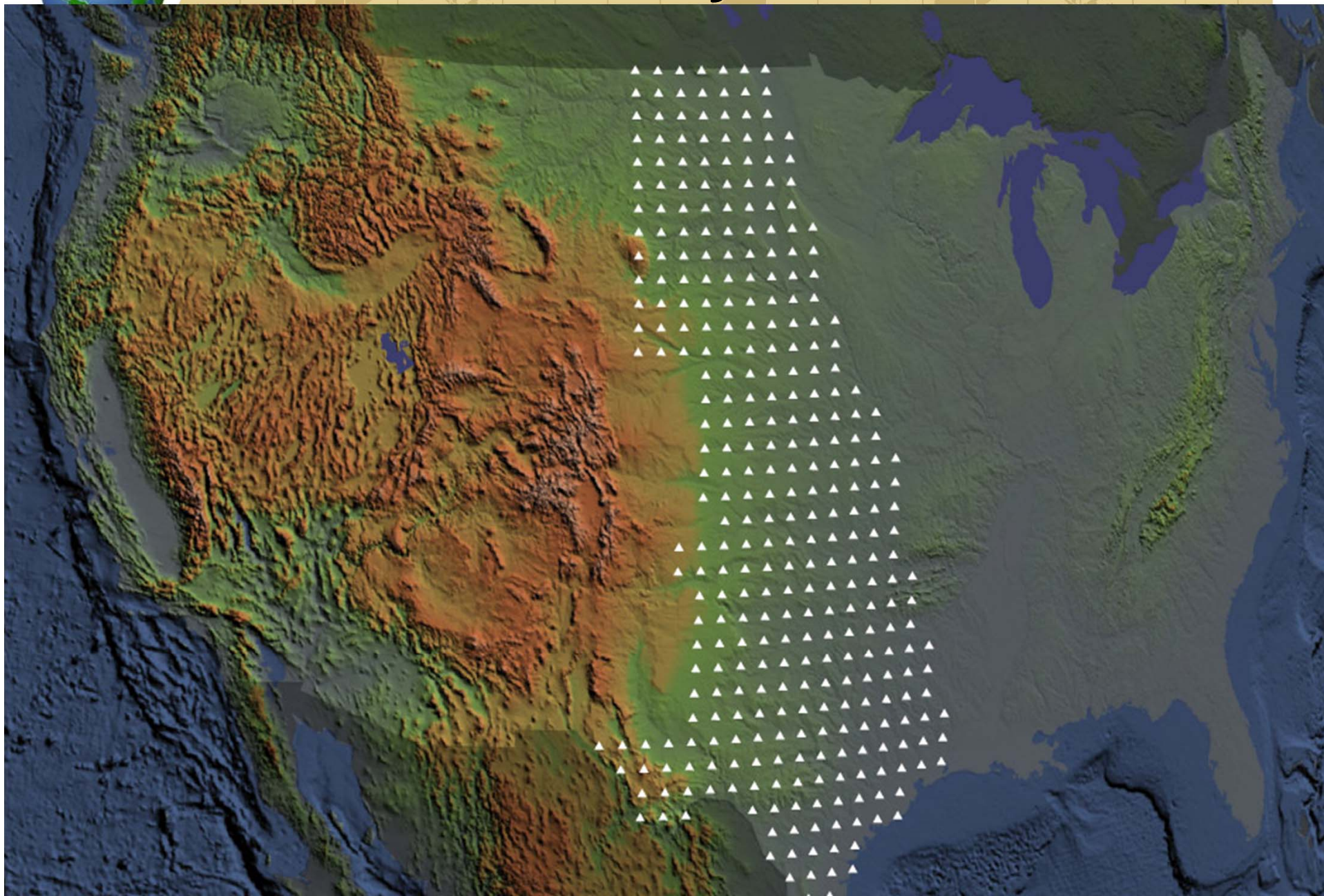
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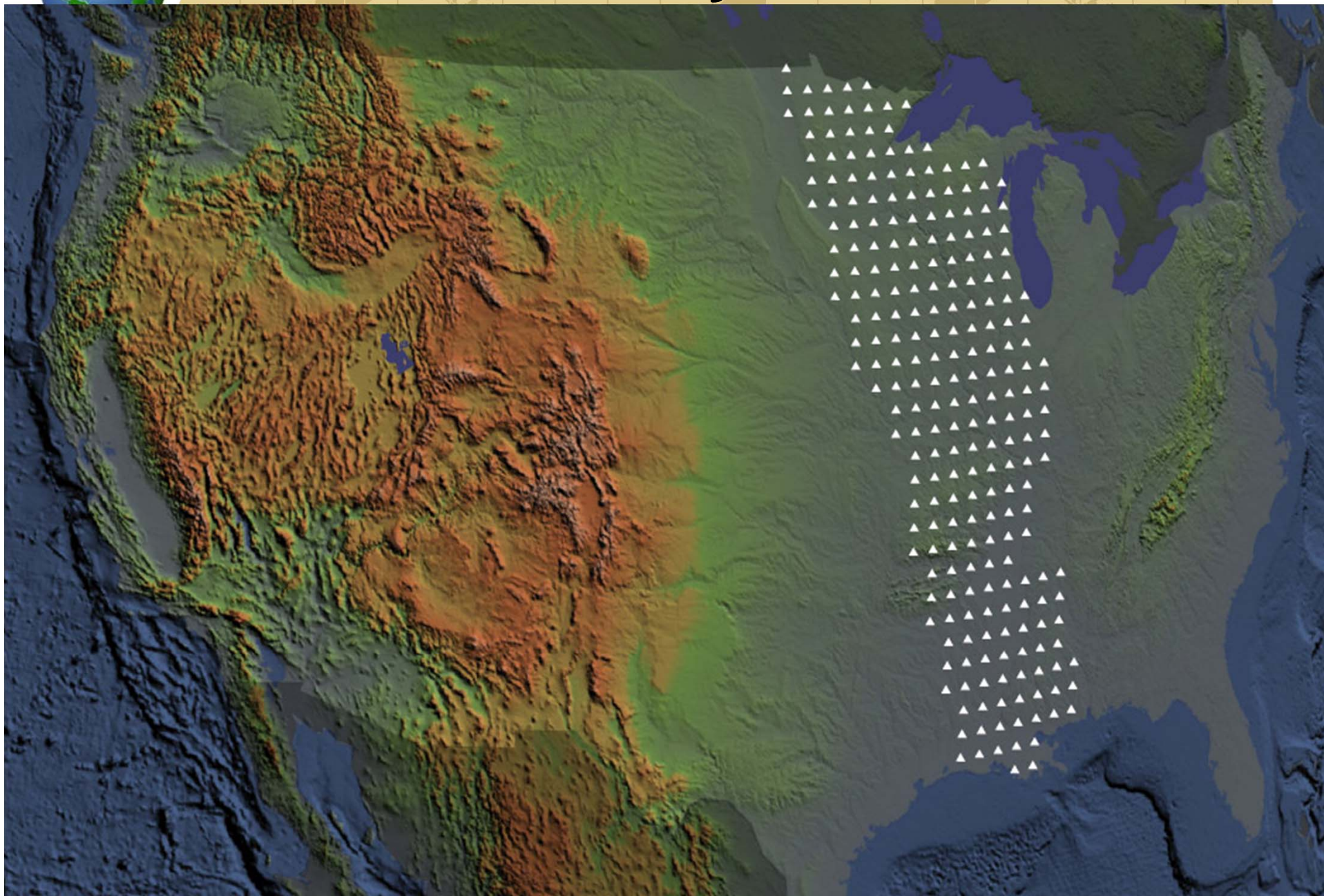
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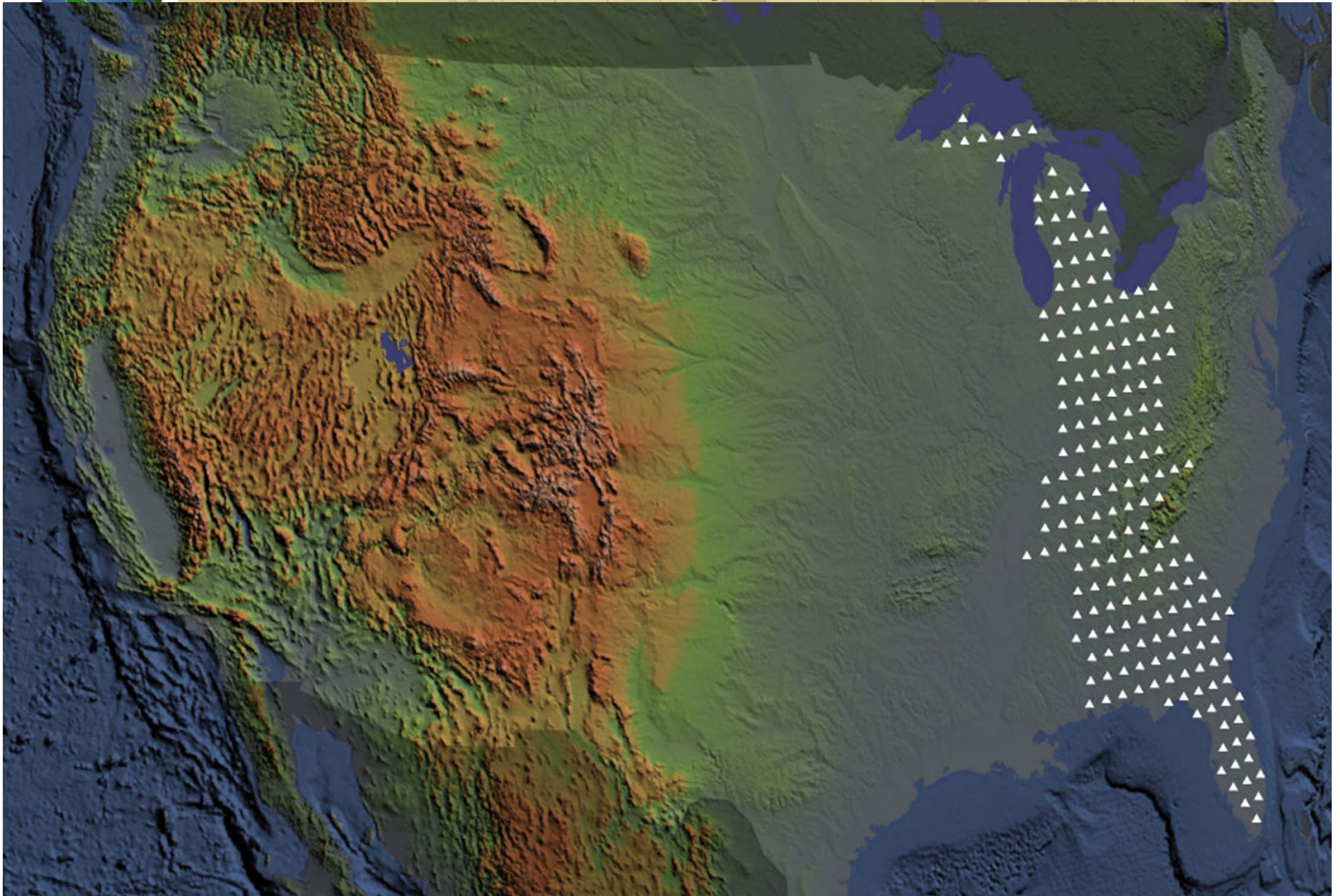
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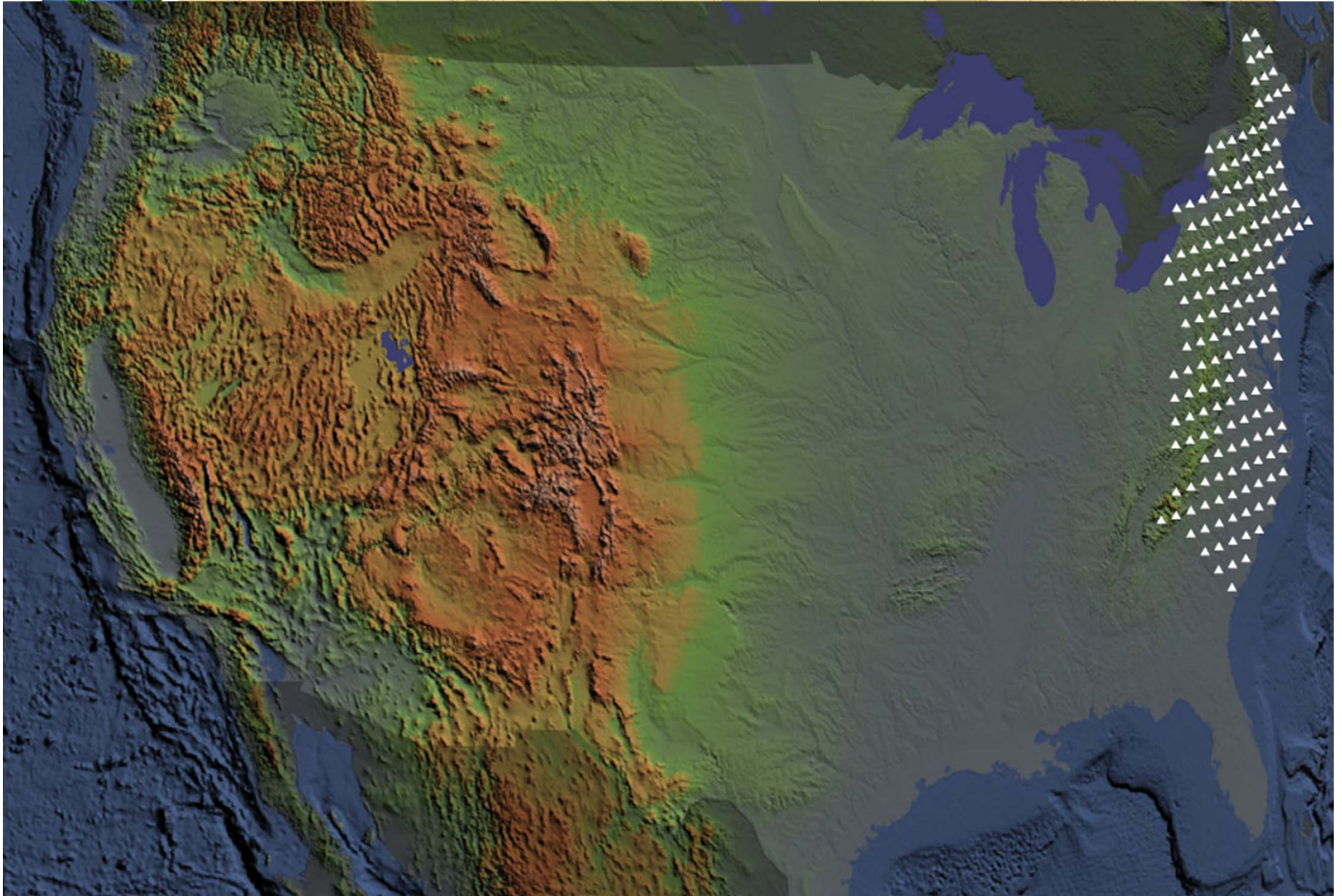
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USArray: 2013

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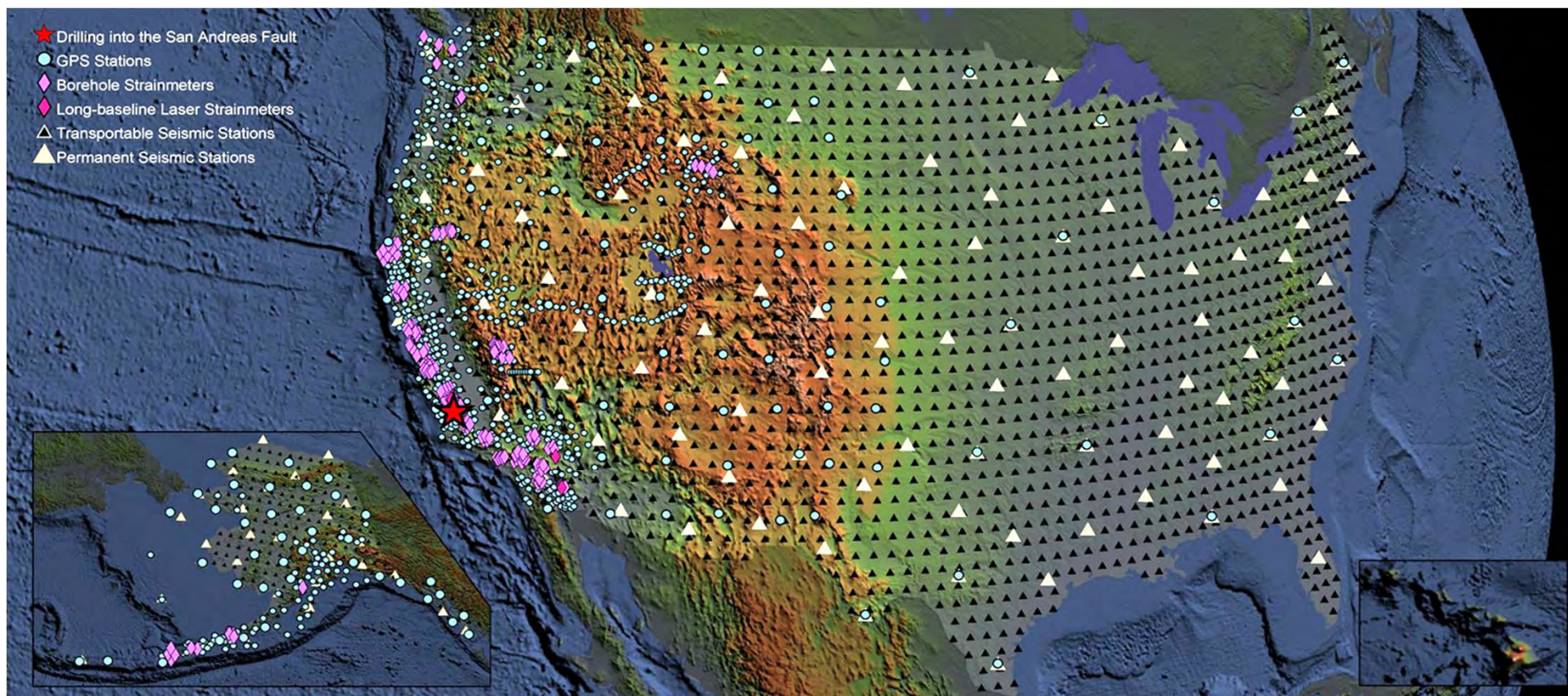




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EarthScope Instrumentation

- 3.2 km borehole into the San Andreas Fault
- 875 permanent GPS stations
- 175 borehole strainmeters
- 5 laser strainmeters
- 39 Q330HR Permanent seismic stations
- 450 Q330 based transportable seismic stations occupying 2000 sites
- 30 magneto-telluric systems
- 100 campaign GPS stations
- 2400 campaign seismic stations



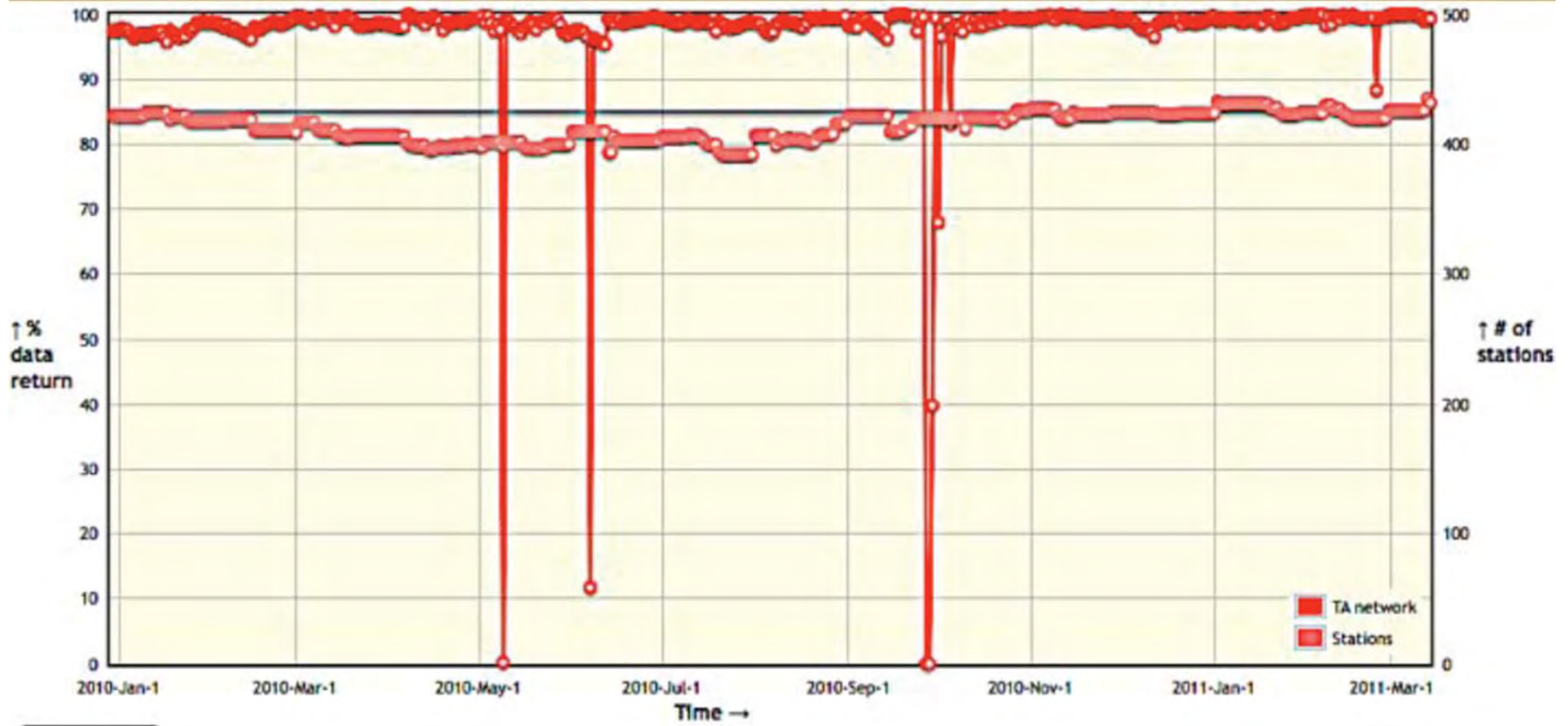


USArray Data Return

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6 days 100.00% Data Return

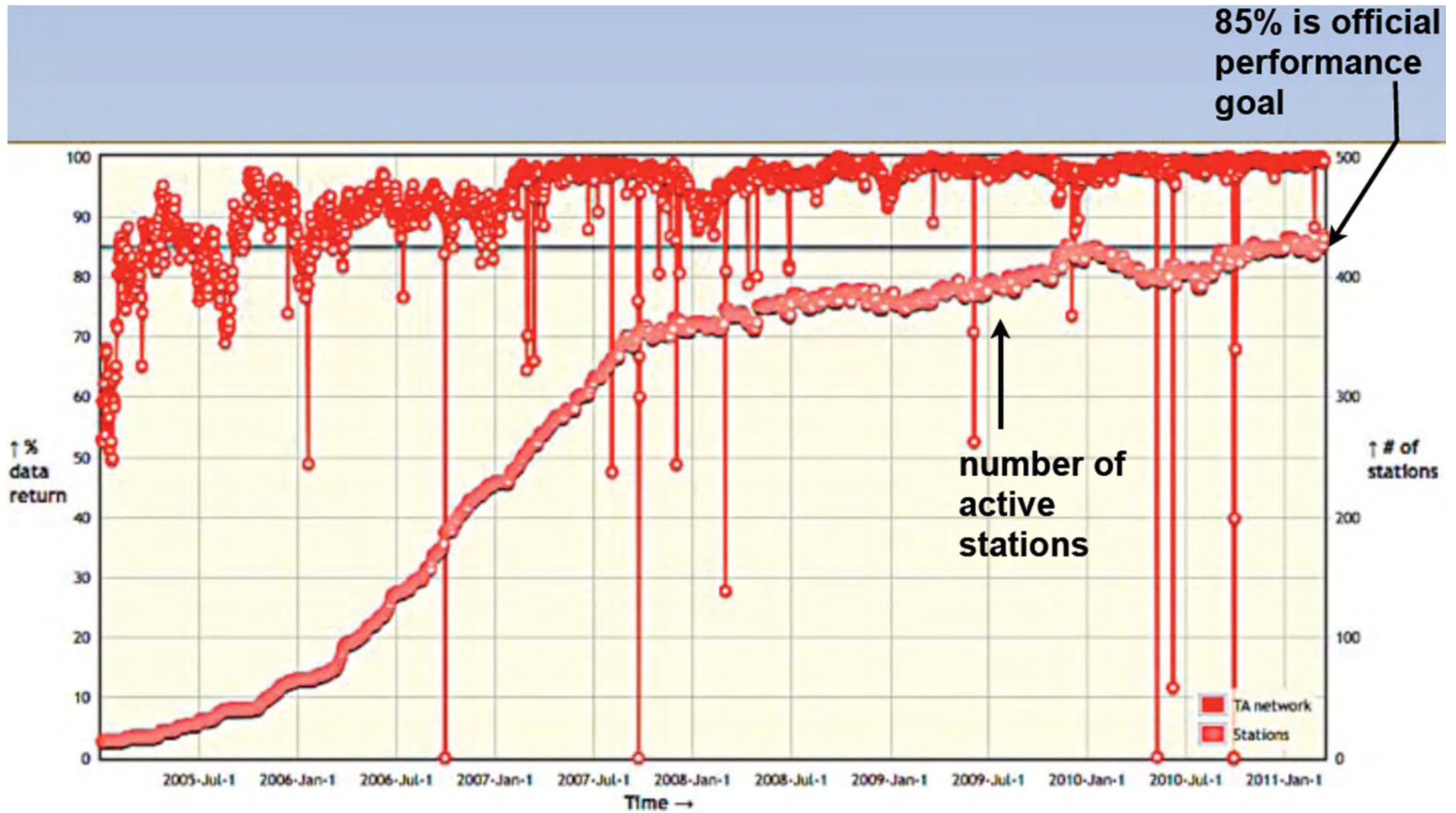
Mean Data Return - 97.37%
Median Data Return - 98.90%





USArray Data Return

Company Confidential



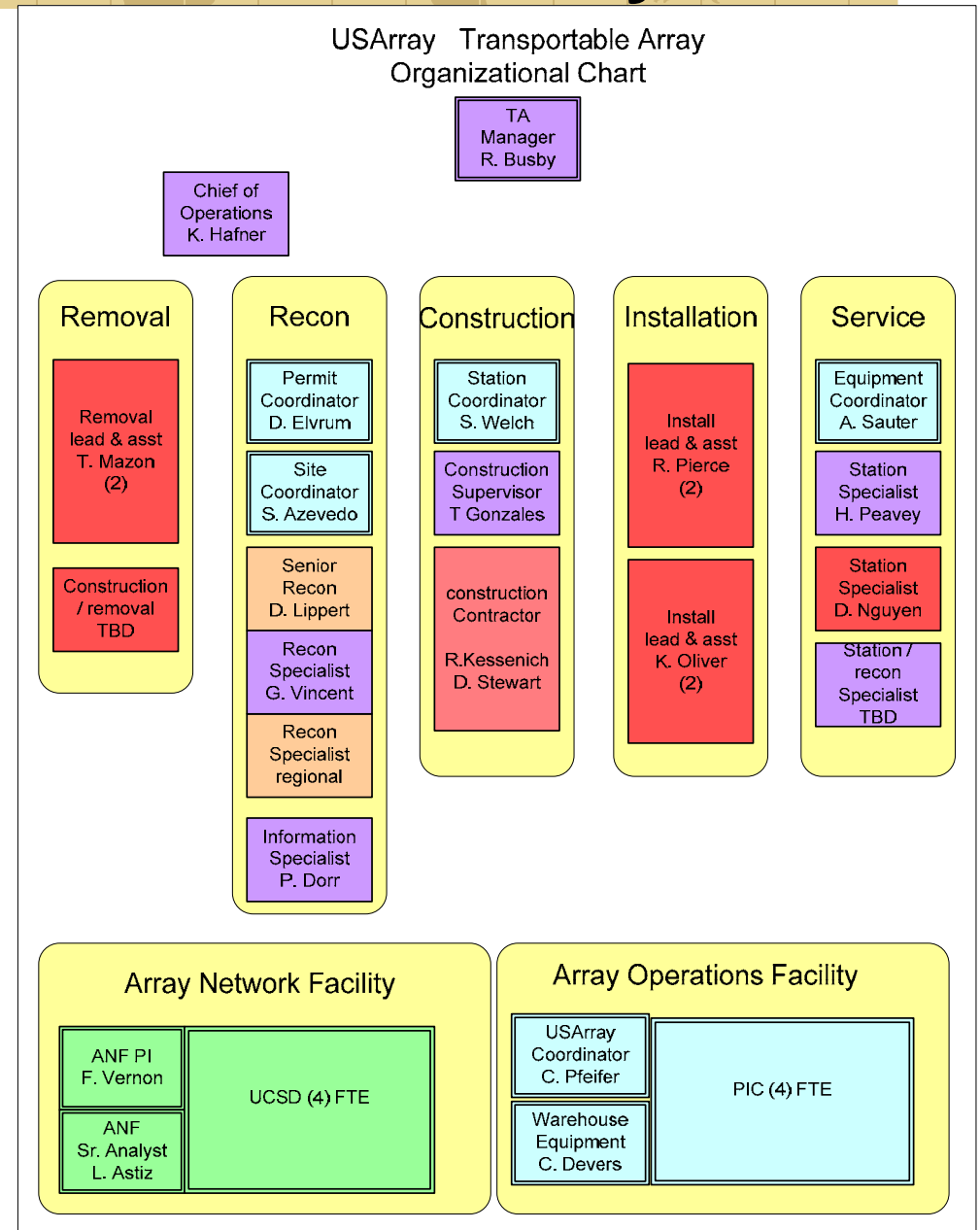


USArray: Organization Summary

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34 Team Members

- **Management:** 2.0
- **Recon:** 5.0
2.5 office
2.5 field team
- **Construction:** 4.0
1 office
3 field crew
- **Installation:** 4.0
4 field crew
- **Service:** 4.0
4 field crew
- **Removal:** 3.0
3 field crew
- **Support Facilities:** 12.0
AOF NM Tech 6
ANF UCSD 6
- **20 Installation/Month**





United Arab Emirates:

Company Confidential

- ❖ Client: Abu Dhabi Municipality
- ❖ Project: Seismic Risk Assessment and Loss Estimation
 - Seismic Hazard Assessment and Seismic Zoning of Abu Dhabi Municipality (ADM)
 - Site Amplifications and Microzonation
 - Seismic Design Code
 - Seismic Risk Analysis for 4 Critical Importance Life Lines
 - Seismic Risk Analysis of 4 Critical structures
 - Structural Health Monitoring for 4 Unique Structure
 - Permanent Real-time 30 station Accelerograph Network
 - Permanent Real-time Seismic Monitoring Network
 - Ground Motion Estimation Maps (i.e. Shake Maps)
 - 3D Seismic simulation Model to Simulate Long Period Seismic Waves
 - Seismic Performance and Risk of ADM Tall Buildings
 - Seismic Risk Assessment and Loss Estimation
 - Seismic Data Base and GIS Shell for Management, Maintenance, and Modification of Seismic Data Base Products
- ❖ KMI Largest project.
- ❖ Status: Implementation Phase



NEW Developments!



Q330S+

- ✦ Leverages on Quanterra's extensive experience in ultra-reliable seismic systems design, and combines sampling up to 1kHz with ultra-high low-frequency resolution.
- ✦ Crossover of the Q330 and Q330HR performances
 - ✦ Typical ~138dB wideband RMS, Low-frequency may exceed 145dB
- ✦ Sampling rates: 1000, 500, 250 200, 100, 50, 40, 20, 10, 1.
- ✦ 2 PC/MAC/linux-formatted removable USB media, up to 256GB each.
- ✦ No need for any additional software for file transfer or data read.
- ✦ All unit operative -40 to +70C.



NEW Developments!

Company Confidential

QUANTERRA Q330S+



General Description

The Q330S+ is the newest member of the world-standard Q330 family, and is an advanced 3 or 6 channel broad-band, high resolution seismic system incorporating Quanterra's proven IP networking technology into a very low-power field package. The Q330S+ leverages Quanterra's extensive experience in ultra-reliable seismic systems design, and combines sampling up to 1kHz with ultra-high low-frequency resolution.

Telemetry...



...and Local Recording



The Q330S+ supports real-time data telemetry to up to 3 independent central sites *and* internal, reliable local low-power USB recording system, *simultaneously*. Recording may be cycled to conserve power.

Low Power

Incorporating the latest low-power technology, the Q330S+ achieves integrated capability with an average power (cycled mode) requirement of ~0.75W, including recorder & GPS

Internet-Ready Industry Standards

The telemetry protocols use industry-standard stateless IP communications over UDP or TCP transport layers, enabling the use of off-the-shelf IP equipment and service providers. The Q330S+ is designed for simple and powerful network maintenance and administration

Comprehensive Sensor Control

The Q330S+ is a seismological instrument, not a digitizer alone. Sensor control & interface, including calibration, and sensor identification-tag support is built in.

Specifications

Specification	Description
Channels	3, optional 6-channel
Dynamic Range	Typical ~138dB wideband RMS Low-frequency may exceed 145dB
Format	32-bit integer, Level 2 compressed 1-second packets
Input Range	40V P-P at gain=1
Gain	Selectable per channel group: 1.8,32
Filtering	Linear or Minimum Phase FIR
Sample Rate	1000, 500, 250, 200, 100, 50, 40, 20, 10, 1. Other rates available.
Time Base	Precision TCXO, locked to GPS. No adjustment.
Telemetry (real-time)	Full Duplex, low-latency efficient positive acknowledge with error control. UDP/IP over serial and Ethernet. Burst or continuous. Operates with major application software.
Data storage and retrieval	2 PC/MAC/linux-formatted removable USB media, 16G each (128G in development). Industry-standard Standard HTTP, FTP, and SSH servers for remote retrieval.
Temperature	Fully specified -20 to +50C Operative -40 to +70C
Sensor Control	Calibrate: step, low-THD sine, or random. Recenter, on-command
Operational Data	Temp, DC voltage, GPS status, Sensor boom position (6 chan)
Memory	128Mb RAM standard
Network	Dual Ethernet (10BT & 10/100BT) Full IP Protocol Stack (Linux), DHCP
Serial Ports	1 console port up to 115kbaud.
Media	Dual USB up to 32GB total, failover. -40 +70 rated media available.
Power	12VDC nominal ~0.7W avg. 3-channel (cycled) ~1.0W avg. 6-channel (cycled) ~2.4W avg. 6-channel (continuous)
Physical	Sealed, Aluminum, 17 X 4 X 6 in., 10 lbs., Rubber endcaps, Externally visible status and fault indicators.

Q330S+ QUANTERRA, INC.- 2 Shaker Rd, Ste. F 200, Shirley, MA 01464, USA 978-425-2100
PRELIMINARY SPECIFICATIONS, SUBJECT TO CHANGE Rev B.



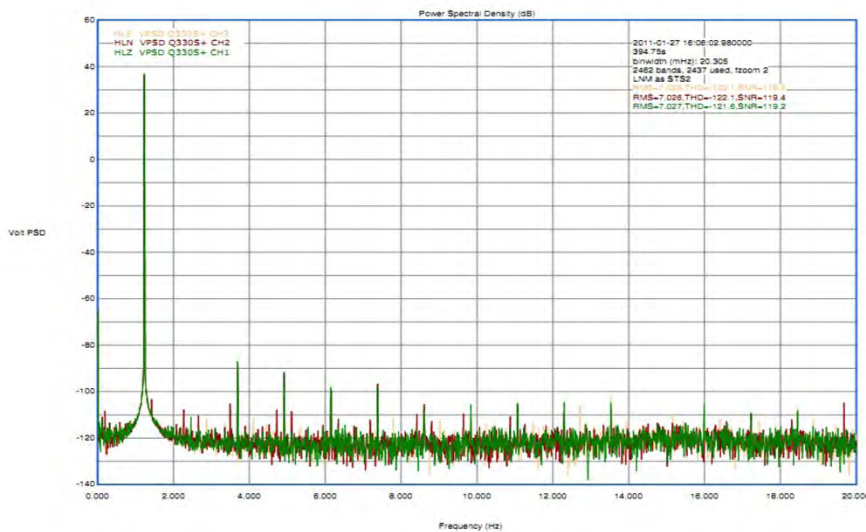
NEW Developments!

Q330S+



- Shipped first 21 units with STS-2.5's to China in July.
- We currently have an additional backlog of over 200 units and more orders expected.

Total Harmonic Distortion of 3 channels Q330S+ (using Quanterra Supertonal Signal Source) indicates -122 dB, and -119dB SNR



16 of the Q330S+ units for China





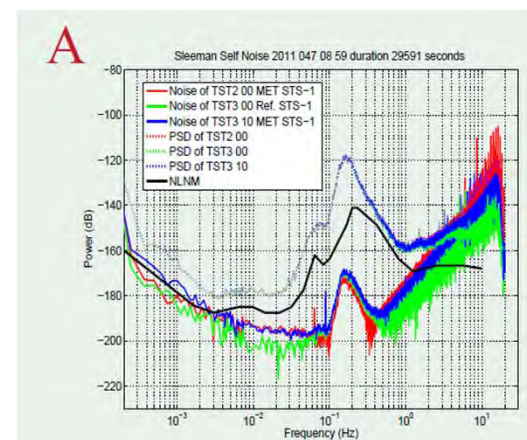
NEW Developments!

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Metrozet VBB Development: M2166-VBB



- ⊕ Most quiet seismometer in the world
- ⊕ Next generation of STS-1 class
- ⊕ Several Installations in US : Harvard, ASL, etc.
- ⊕ Will install a demonstration unit in the French (GSN) Geoscope Network in the fall.
- ⊕ The results from the data obtained from the installation of the unit at ASL have been presented by ASL at the recent IRIS Instrumentation Symposium and are creating considerable interest in the community.
- ⊕ Responded to USGS request for GSN upgrade.
- ⊕ Number of units shipped to USGS in Dec 2011
- ⊕ More units to be delivered (other customers) in 2012





NEW Developments!

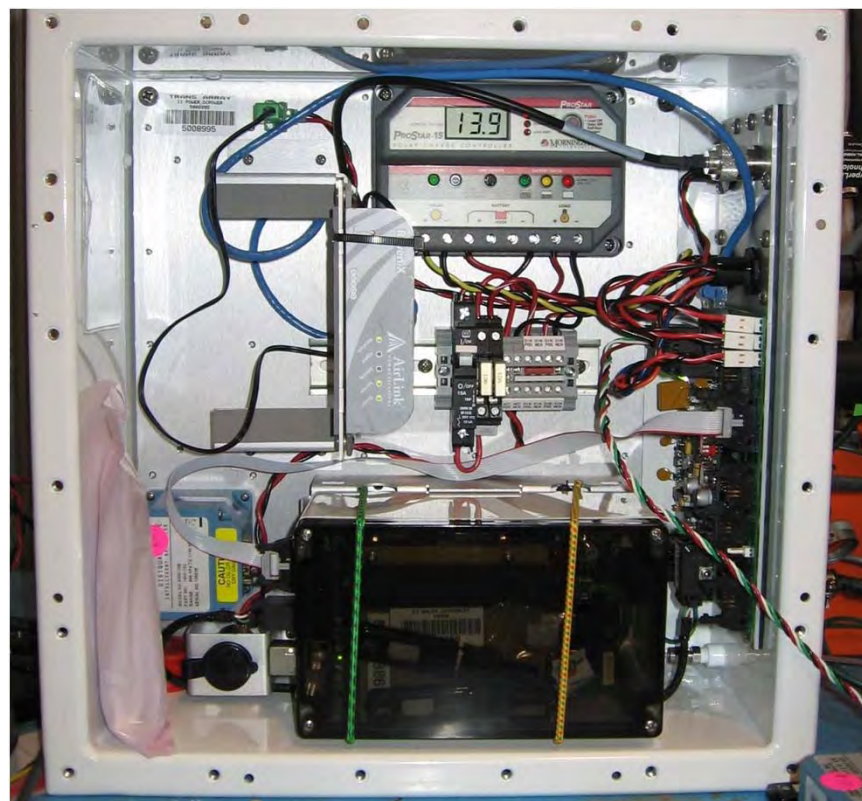
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VIE

Vault Interface Enclosure

❖ USArray demonstrated improved network data return to almost 99% after implementation of the VIE.

- ✦ 16x16x8" Enclosure, hangs inside vault.
 - IP68, 0.5" Lexan Clear lid, bulletproof!
- ✦ Q330 interfaces converted to industrial standard connections;
 - IDC flat ribbon, RJ45.
- ✦ Custom power regulation circuit
 - Faultfree switchover to alkaline backup battery
 - Signalling via existing data channels for power SOH
 - Sensor power regulation, filtered power for Q330 and Baler
 - High efficiency regulation, load shedding/mode switch on backup power
 - Independent fault isolation of powered devices.
- ✦ Station Integration
 - Integration of new Baler44CT, Environmental sensor
 - Simplified Data collection via new Baler44
 - Reset power cycle for comms equipment
 - Remotely controlled power interrupt for sensor
 - Monitor and signalling of pump operation
- ✦ Protected housing for electronics and auxiliary equipment-allowing better flexibility and increased reliability.
 - Allows economical packaging choices for small ancillary devices
 - Protects commercial modems, charge controllers and circuit boards.
 - Simplifies troubleshooting, acts as a field replaceable unit.
- ✦ Uniform cabling for installation
 - MS style connectors, molded termination
- ✦ Commercial production in large runs; Enclosure, cables, PCB, testing, etc
 - Custom cable fabrication, custom metal, factory assembly and testing.



QUANTERRA, INC.



NEW Developments!

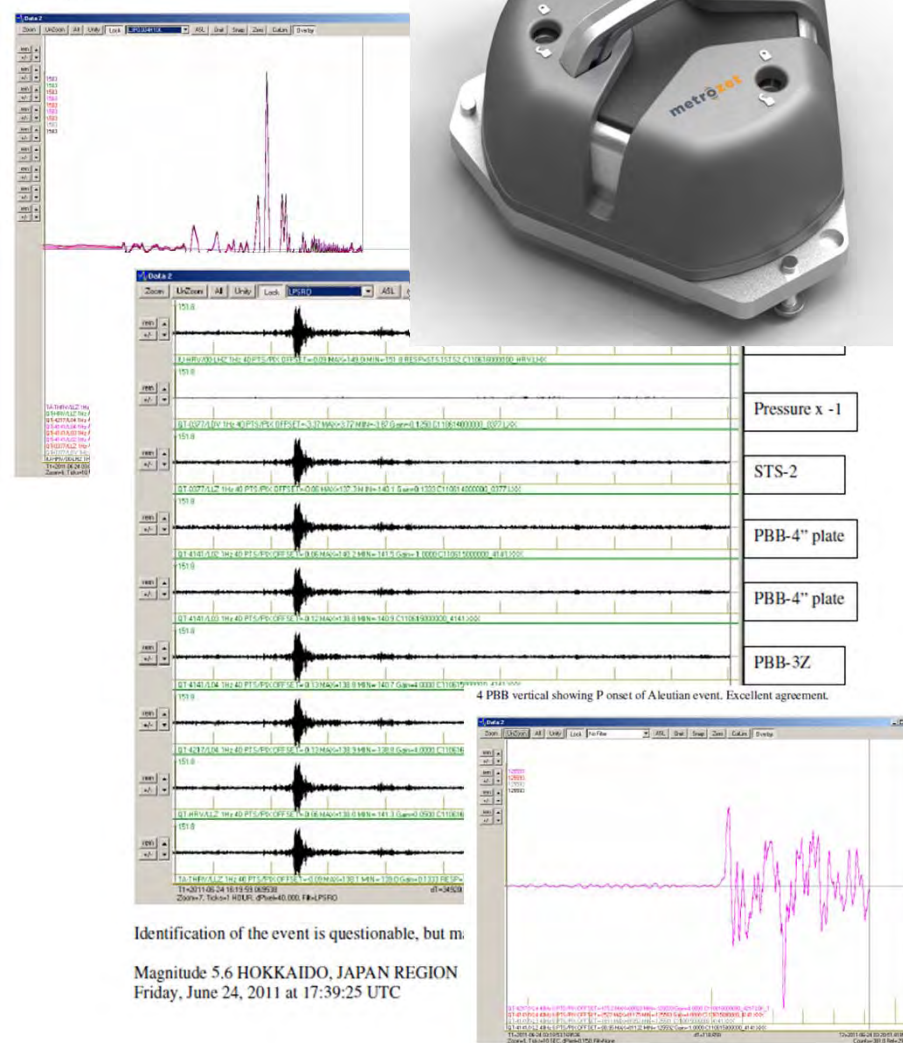
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Metrozet PBB Development: PBB - 200S



We start delivery of NEW Portable Broad Band Seismometer.

- Units have been successfully tested at Harvard and ASL
- The units show greatly improved glitch performance – “After the expected few days, they have settled in with essentially no, or rare, significant glitch production.” (Joe Steim)
- The basic sensor noise performance outperforms sensors of such class
- More....Separate presentation...





NEW Developments!

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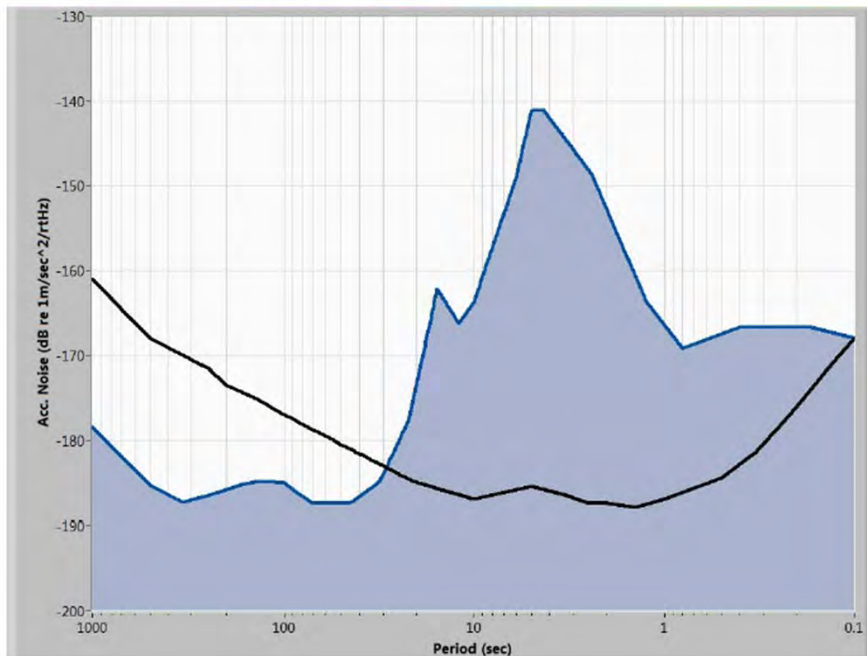
Benefits to You:

- More high fidelity data at a better price
- Lower sensor self-noise than comparable sensors
- Rugged design protects your sensors from damage
- Eliminate non-linearity caused by shipping and handling
- Easy to handle
- Water-tight IP68 housing

Key Features:

- NLNM performance over a broad frequency range
- Genuine warpless baseplate w/complete electrical isolation and an EMI/RFI shield
- 50g-rated mass lock
- Remote diagnostics and operation
- Very reliable connectors and cabling

The figure below shows a typical Self Noise Spectra



PBB-200S Specifications

Sensor Technology	Triaxial, orthogonal feedback sensor elements with temperature-compensated leaf spring	Velocity Output	Industry-standard 40V peak-to-peak, matched to Quanterra data logger input, Z, North, and East
Shock Survival	Mass lock allows more than 50g shocks with no degradation of linearity or hysteresis	Bandwidth	120 seconds to 50 Hz, pole/zero data provided
Self-noise	Below NLNM 30 seconds to 8 Hz	Mass Position Output	Independent, orthogonal mass position outputs for each sensor
Sensitivity	1500 V-s/m, factory trimmed to 0.25%	Calibration	Available; compatible with Quanterra data logger for remote network diagnostics
Cross-axis Sensitivity	Less than 0.2%	Host Box	Included with each unit; isolates more than 95% of total power from the sensor elements for improved performance
Mass Centering	Standard local and remote operations	Serial Port	Available RS-232 for local or remote operation
Leveling	Bubble level and locking feet	Power Supply	1W typical from isolated 9-36V input
Alignment	Precision straight edge on housing	Environmental	Pressure sealed IP68 sensor housing with true warpless baseplate; EMI/RFI shield

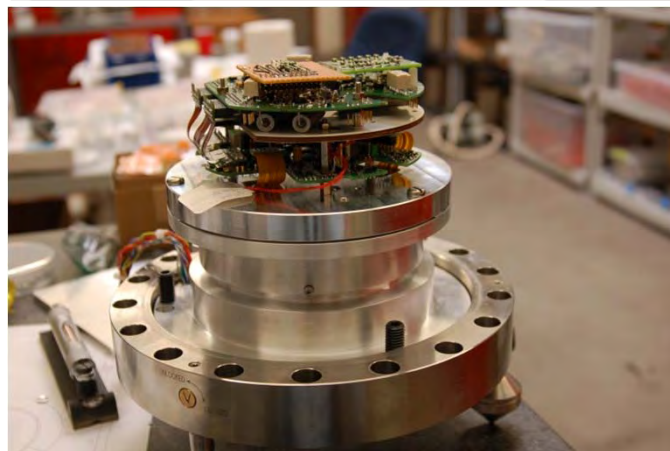
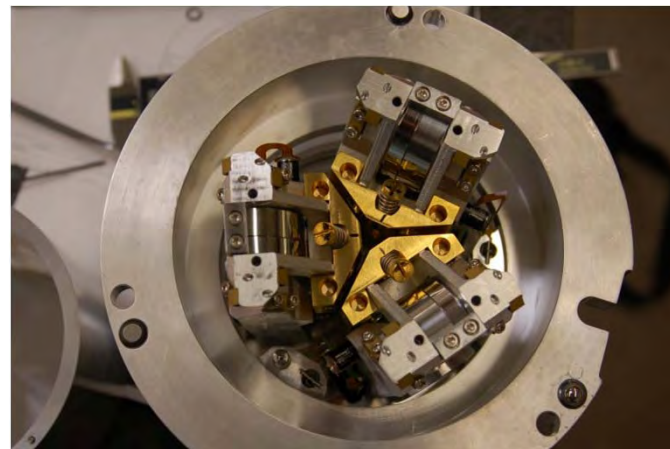


NEW Developments!

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STS-2.5 Post/Borehole and OBS Design

- ✦ Streckeisen/Metrozet/Quanterra development
- ✦ In response to needs for a future Post/Borehole deployment and OBS opportunities we are developing a Post Hole package based on the STS 2.5 units.
- ✦ An initial gimbal structure has been designed, fabricated and integrated with an STS-2.5 sensor deck within a conventional STS-2.5 package. Testing of this has begun.
- ✦ An improved mechanical design has been completed and submitted for mechanical fabrication.
- ✦ A concept design for a pressure-isolated 5.5” diameter cylindrical housing for a gimballed STS-2.5 is developed.
- ✦ First installation in OBS installation early summer 2012



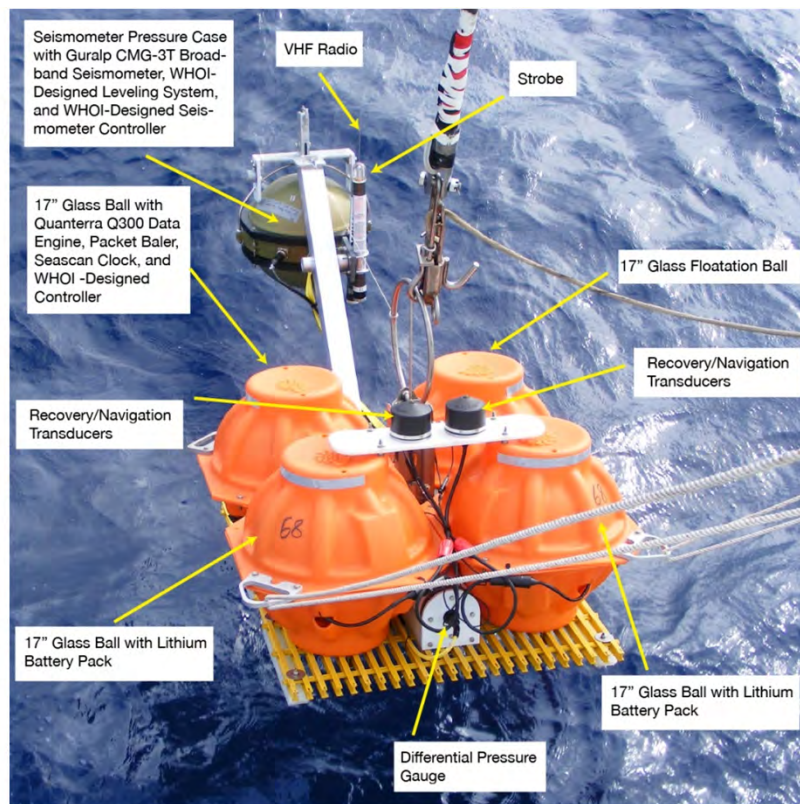
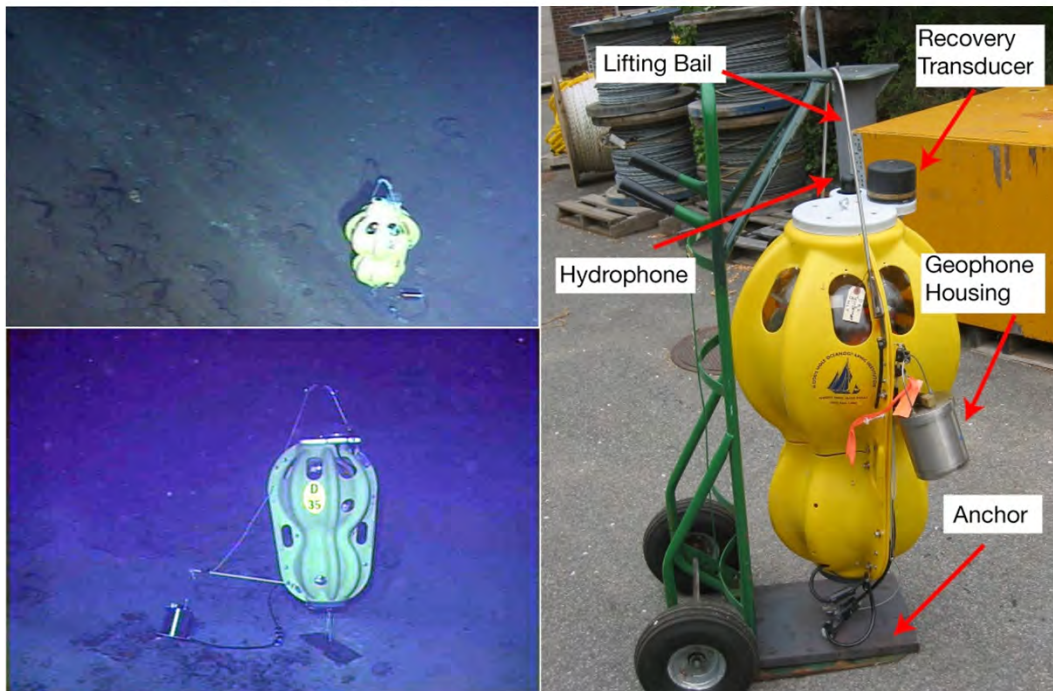


NEW Developments!

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OBS Station

- Based on proven design
 - Started with Woods Hole Oceanographic institution (WHOI)
 - Moved to UCSD Design
 - Operational in many installations worldwide including in US OBS pool



The Short-Period OBS. The instrument is ~ 1m in height. Carries a 3-component 3.5 Hz geophone and a hydrophone. 9 month battery life.

Strong-Motion/Broad-Band OBS. EpiSensor/STS-2.5, Differential Pressure Gauge. Max deployment duration is 1 year.

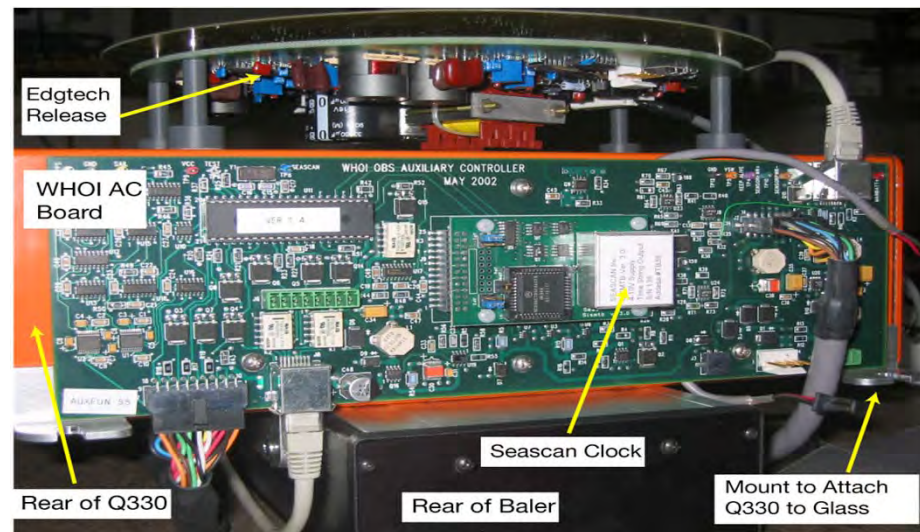
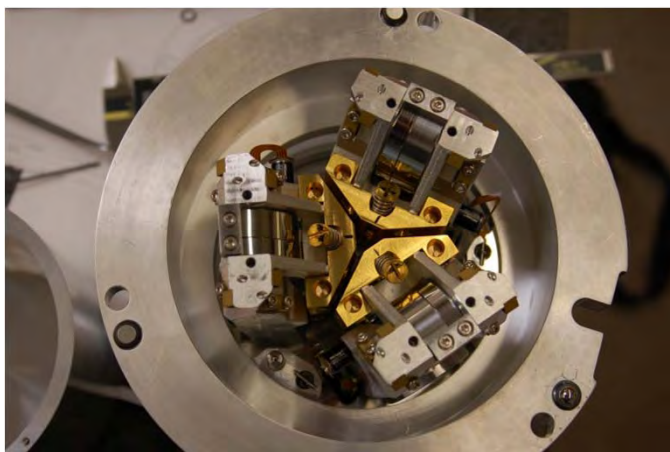
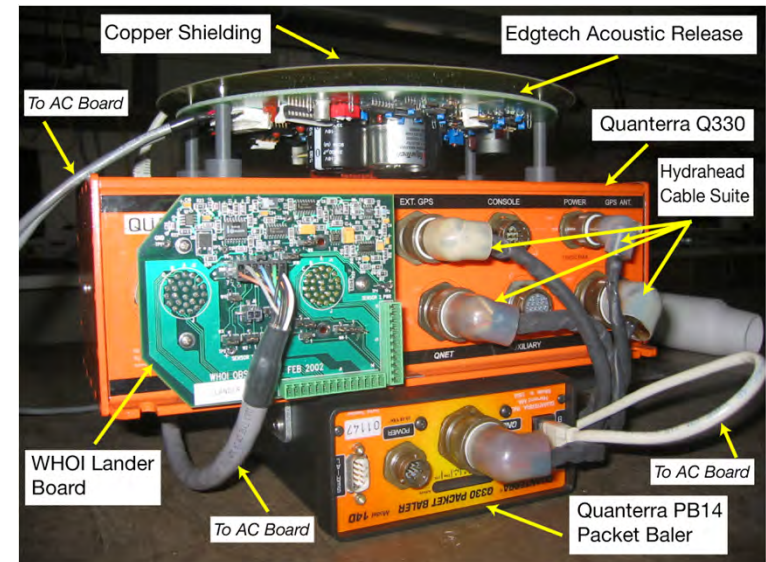


NEW Developments!

Company Confidential

OBS Station and New Improvements

- ✦ New design to support our current project in Caspian sea
- ✦ To support Cable and Autonomous operation
- ✦ WHOI OBS design incorporates the Q330 and PB14/44 since early 2000.
- ✦ New Design will incorporated Gimbal structure for the STS-2.5 sensor deck.
- ✦ New timing system to allow aging $< 3.0e-10$ /month

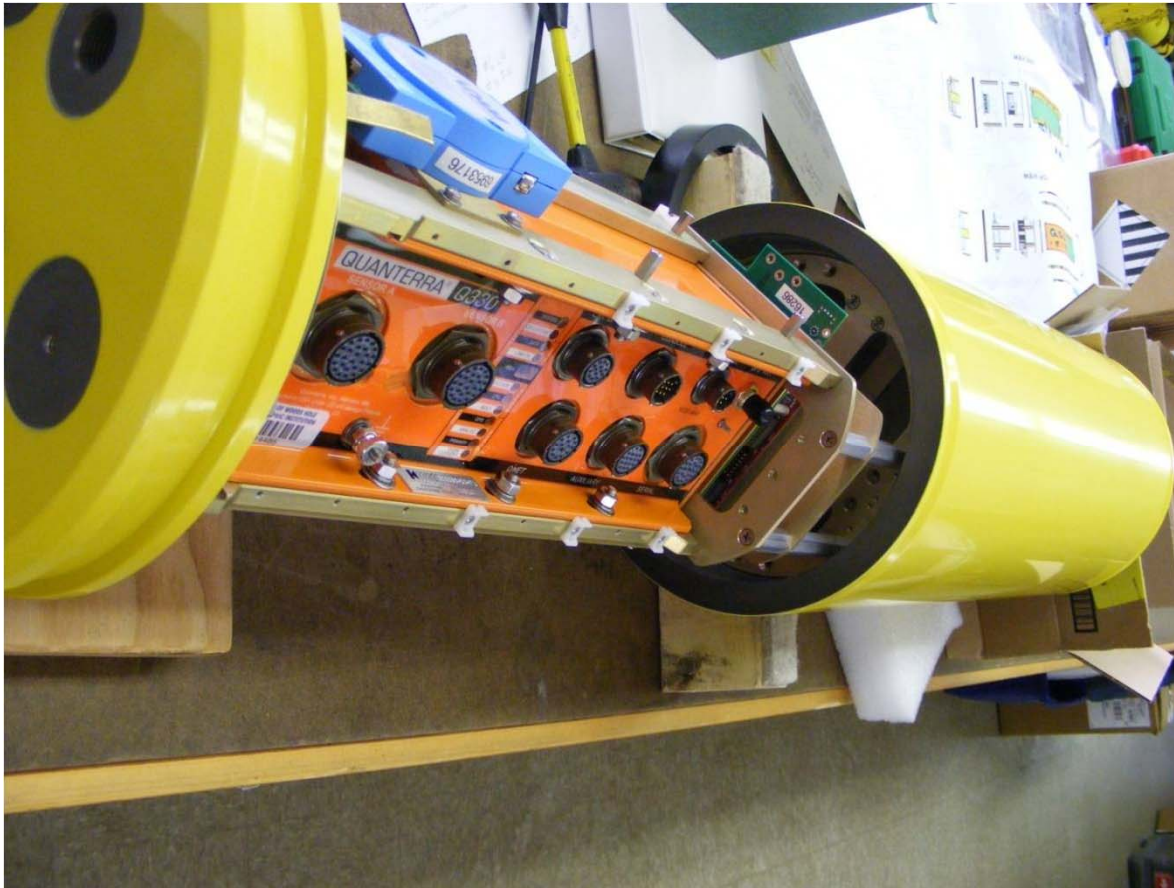




NEW Developments!

Company Confidential

OBS Station



New Design: Q330 and Baler-44; All electronics in Al pressure housings; Syntactic foam floatation.

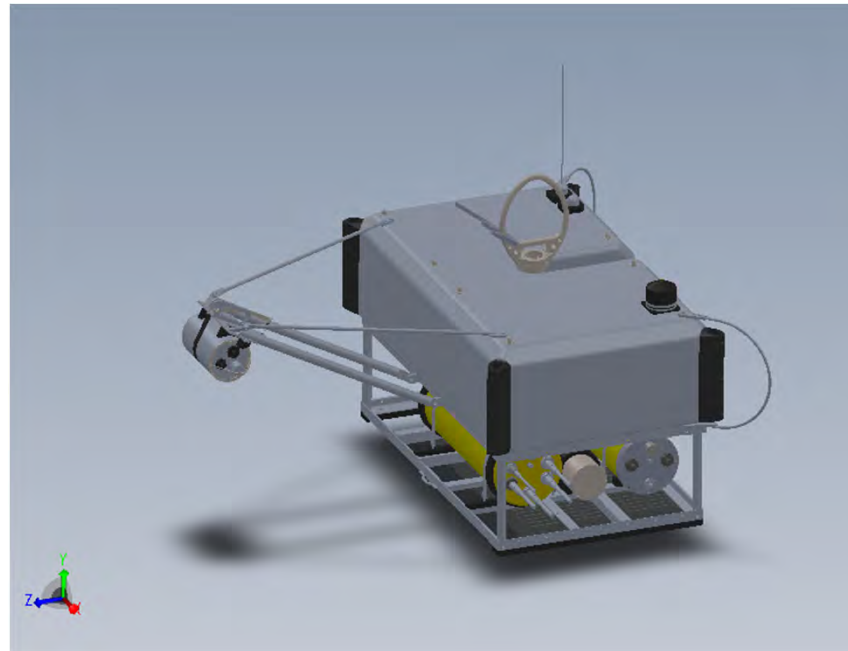


NEW Developments!

Company Confidential

OBS Station

- ✦ To support Cable and Autonomous operation



New Autonomous OBS Design: STS-2.5, Q330 and Baler-44; All electronics in Al pressure housings; Syntactic foam floatation.



NEW Developments!

EQ Early Warning and Basalt



- ⊕ Basalt modes of communication
 - ⊠ Through Ethernet Port
 - ⊠ Using Serial Port
- ⊕ The packet size is 1 second and cannot be made smaller.
- ⊕ Basalt basic latency for normal operations is 1-2 seconds.
- ⊕ However, there is a way to get real-time data through a serial link:
 - ⊠ Samples with essentially “no latency” on a “sample by sample” basis and data could be GPS tag tagged (DFS Option.)
 - ⊠ Telemetry lossless data is not guaranteed, since getting every sample through a serial link with no latency precludes all the good stuff needed for lossless data telemetry.
- ⊕ More in the next Presentation



NEW Developments!



E. Early Warning: Basalt & GPS

- ⊕ Accelerometer
 - ⊞ Double integrations is always challenge
- ⊕ Geodetic quality GPS provides direct displacement
- ⊕ Required: Accelerograph and Geodetic quality GPS co-location
 - ⊞ Basalt & Trimble GPS NetR9
- ⊕ Basalt to provide:
 - ⊞ GPS physical interfaces
- ⊕ Basalt to provide onboard Data Processing
 - ⊞ 2 data streams and to Derive a good displacement time series
- ⊕ Antelope Data Center to collect packetized info, visualize and to disseminate info to stakeholders
 - ⊞ Command and Control





NEW Developments!

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New Line - EqMet: TSA-SMA

- ✦ Low Cost Strong Motion IP Accelerograph that incorporates exceptional performance Metrozet TSA-100S accelerometer (Non-MEMS sensor) and with built-in GPS timing
- ✦ TSA-100S sensors have noise floor of 22 nano-g/root Hz @ 1 Hz (seismic grade)

Market:

- ✦ Noisy, lower-grade Strong Motion sites (deployments)
- ✦ Target product coming from Guralp, GeoSig, Reftek; especially those who use MEMS sensor (Current Low-cost products based on industrial-grade MEMS sensors are 20 - 40 dB worse from TSA-100S)
- ✦ Target Selling Price <\$5,000

Time Scale & Costs

June	FY11	Design Finished and Given to Production for Manufacturing
Sept	FY11	Production Units Available
Oct	FY11	First Delivery to Taiwan

Development & Other Risks

- ✦ Production Cost Containment to meet Target Selling Price
- ✦ Market acceptance...
- ✦ Is there traditional Strong Motion Market?





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Thank You!