icdp
INTERNATIONAL CONTINENTAL SCIENTIFIC DRILLING PROGRAM

ICDP Training 2016

Physical Property Data in Scientific Drilling Projects

Data Acquisition, Preparation and Processing

Data and Project Management

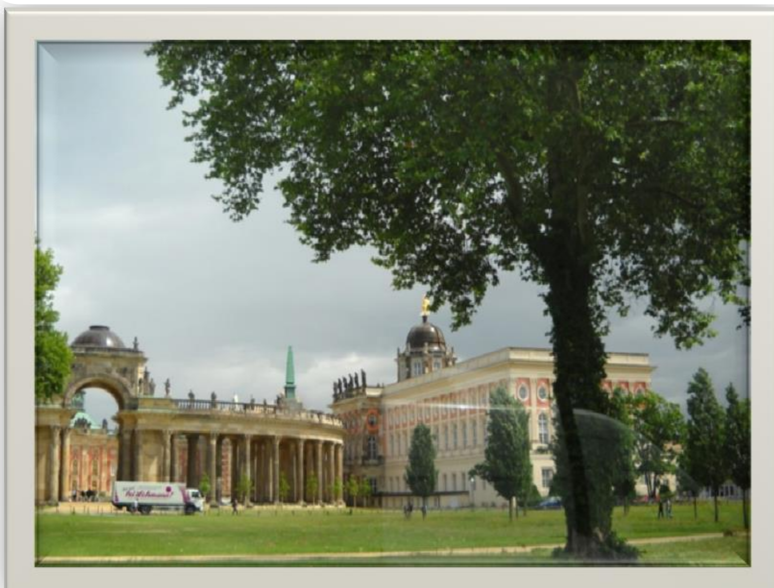
Mentorship and Skills Acquisition

International Continental Scientific Drilling Program (ICDP)
Ronald Conze (DIS Zen Master) Thomas Gorgas (DIS Student)

Physical Property Data in Scientific Drilling Projects

- ✓ Bulk Density
- ✓ Porosity
- ✓ Magnetic Suceptibility
- ✓ Sound Speed (P-Wave Velocity)
- ✓ Natural Gamma Radiation (NGR)
- ✓ Thermal Conductivity
- ✓ Color Reflectivity
- ✓ RGB Color
- ✓ Permeability *(not standard!)*
- ✓ Images

Willkommen, 환영, 欢迎, 歡迎, karşılama, benvenuto, bienvenue, Namaste/स्वागत, HI/Aloha/Howdy, Bem Vindo, ברוכים הבאים, ...



Physical Property and other Data in Scientific Drilling Projects

?

Physical Property and other Data in Drilling Projects

1. **Where and why to go when you want to have such data?** Drill Ship, Drill Site on Land - a short overview about the locale you are getting yourself into
2. **What tools exist to make your data work for you?** IODP's and ICDP's data acquisition machines and tools: Core Labs, Drilling Information System ("The DIS"), other tools (time-dependent: showcase demo's after PPTX)
3. **Quality of Data** – Why that is key and how to make it key for your project: Do you have the basics down? (showcase demo after PPTX)
4. **From one to multiple data sets** - "Core-Downhole Logging-Seismic Data Integration": Feeding together on the "Data Pasture"

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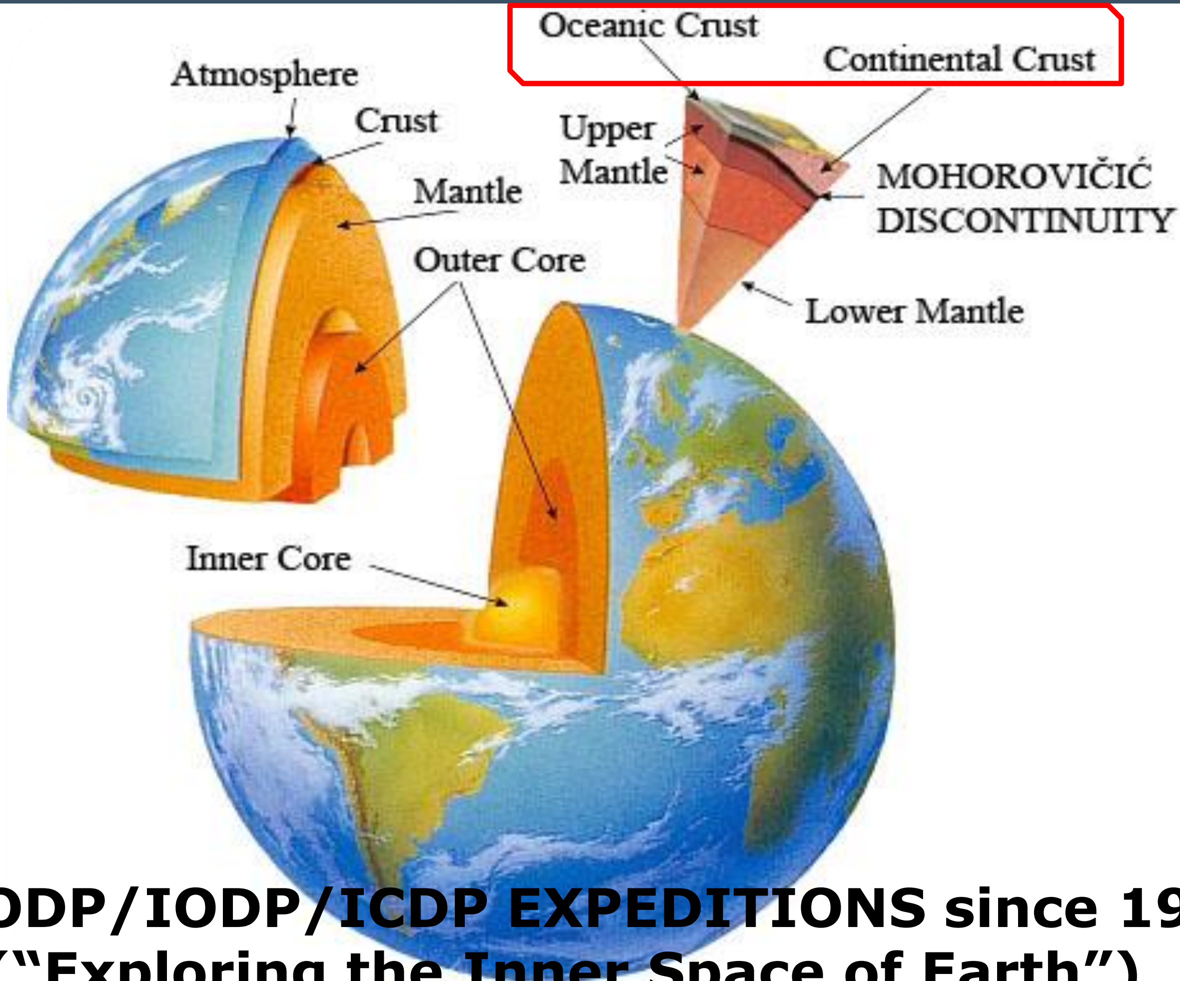
1: Where and why to go when you want to have certain data



DSDP/ODP/IODP/ICDP EXPEDITIONS since 1960-ties
("Exploring the Inner Space of Earth")

1: Where and why to go to when you want to have data

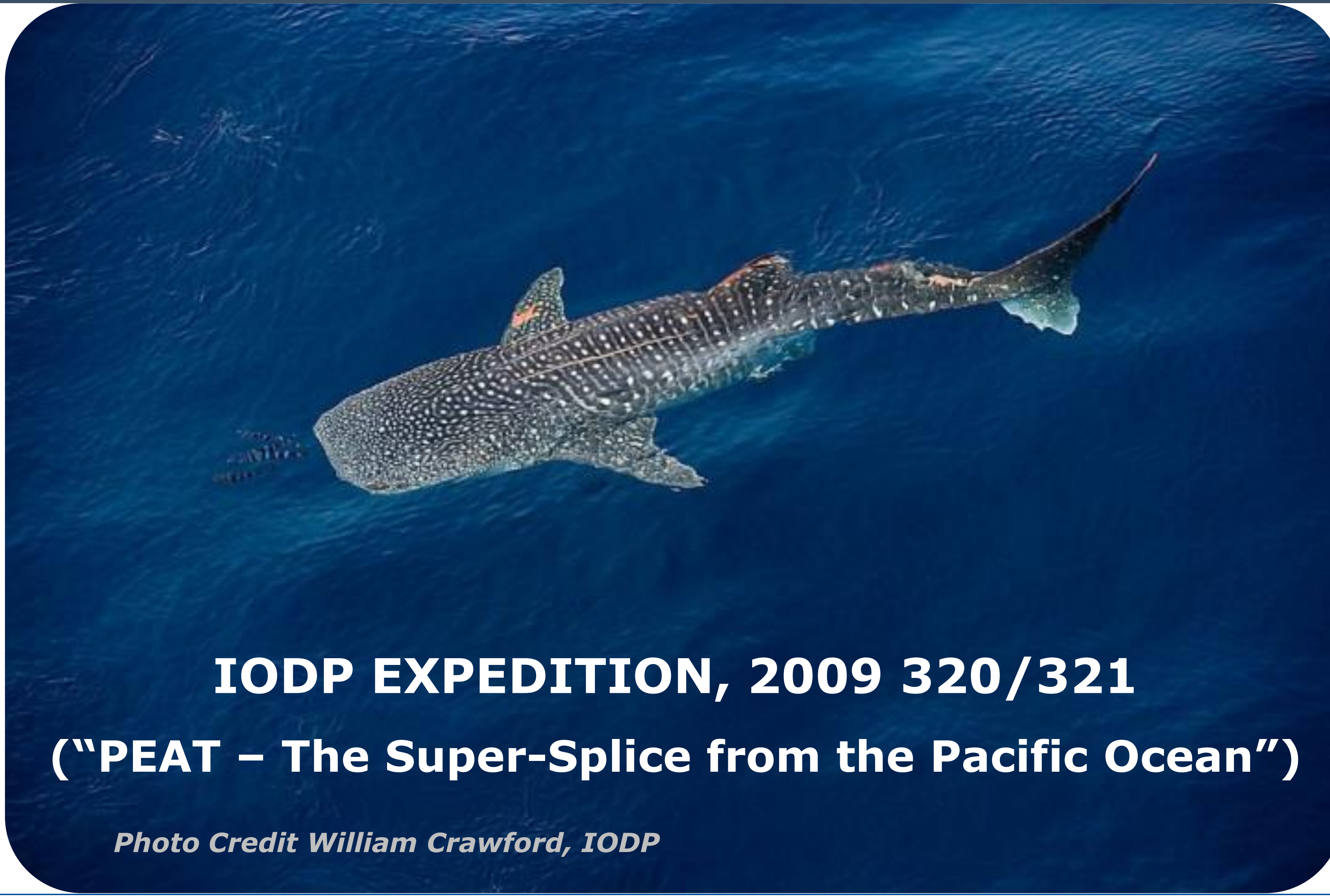
IODP: International Ocean Discovery Program

Texas A&M University 2013 - 2023

JOIDES Resolution,
Curaçao 2011

Photo Credit William Crawford, IODP

1: Where and why to go to when you want to have data



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1: Where and why to go to when you want to have data

IODP EXPEDITION 318, 2010 (“Wilkes Land, Antarctica”)

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1: Where and why to go to when you want to have data

IODP EXPEDITION 346, 2013 ("Asian Monsoon")

Photo Credit William Crawford, IODP

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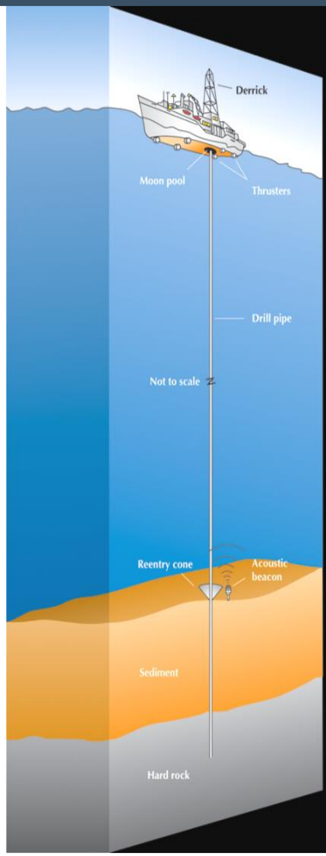
1: Where and why to go to when you want to have data



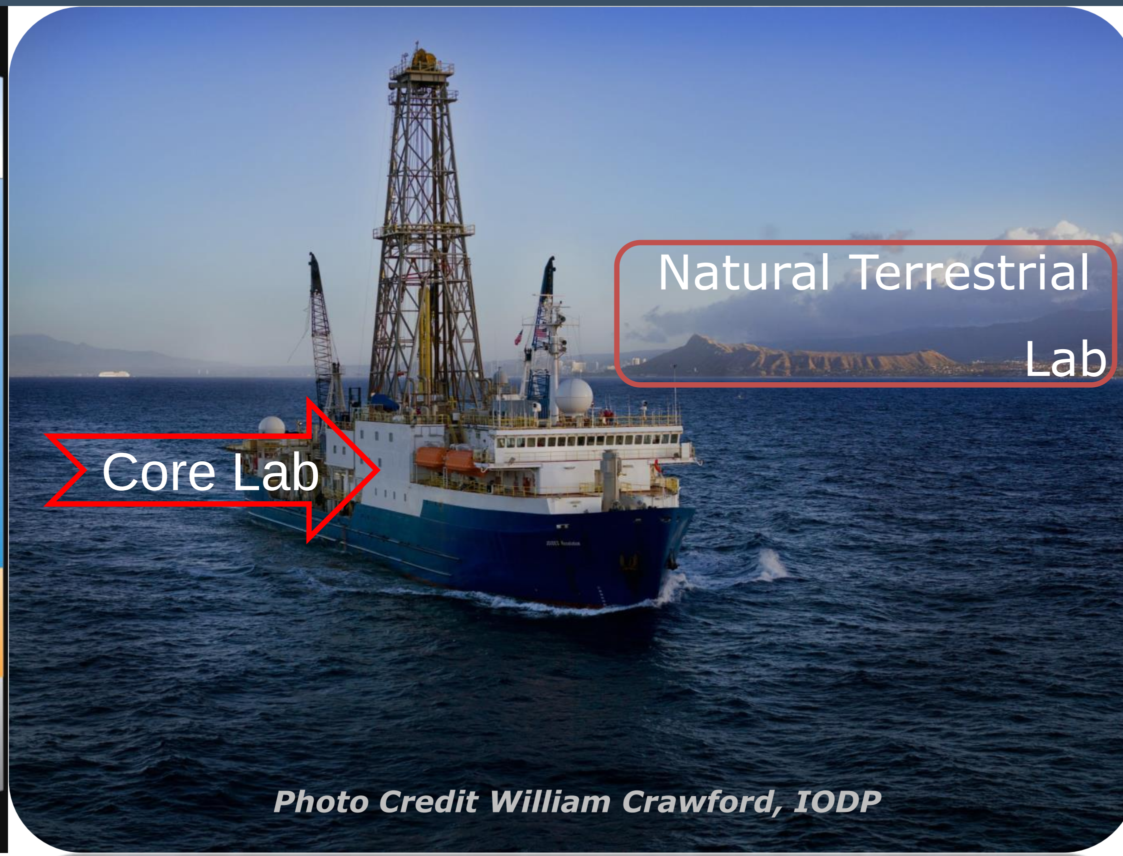
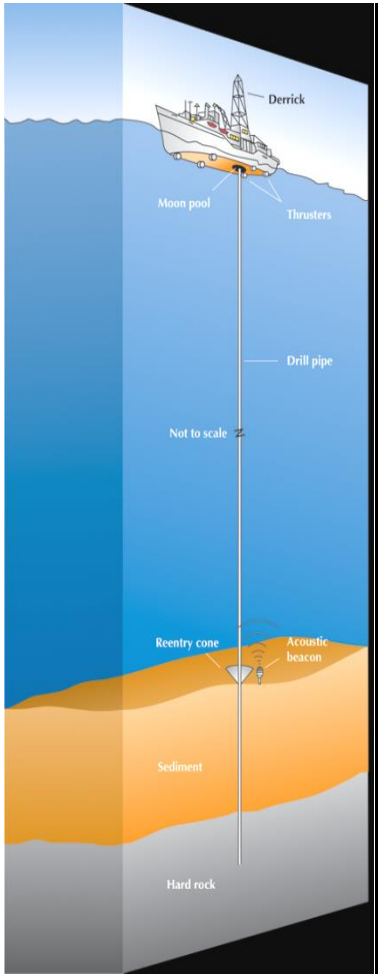


Photo Credit William Crawford, IODP

DSDP/ODP/IODP EXPEDITIONS since 1960-ties
(“Exploring the Inner Space of Earth”)

1: Where and why to go to when you want to have data



JOIDES RESOLUTION: Capabilities

- Drill ship with dynamic positioning
- 75 days at sea without re-provisioning
- Can suspend up to 27,000 feet (~8200 m) of pipe
- 130 berths (60 for scientific and technical staff)
- 18,000 square feet of scientific labs
- 26,000 cubic feet of core storage
- Labs: sedimentology, petrology, microscopy, paleontology, paleomagnetism, petrophysics, stratigraphic correlation, downhole measurements, chemistry, microbiology, XRD, underway geophysics
- Computer network & database services

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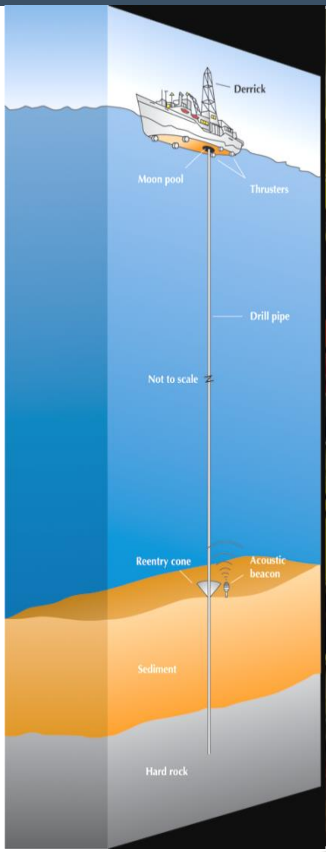
1: Where and why to go to when you want to have data



DSDP/ODP/IODP EXPEDITIONS since 1960-ties
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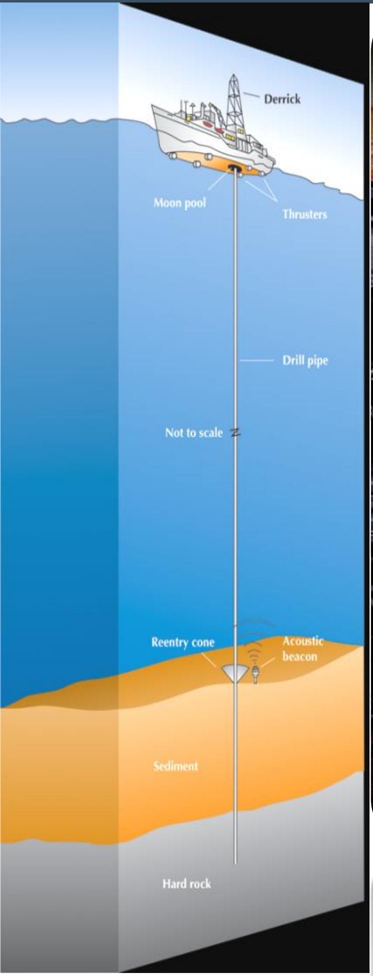

Dealing with Failure

DSDP/ODP/IODP EXPEDITIONS since 1960-ties ("Exploring the Inner Space of Earth")

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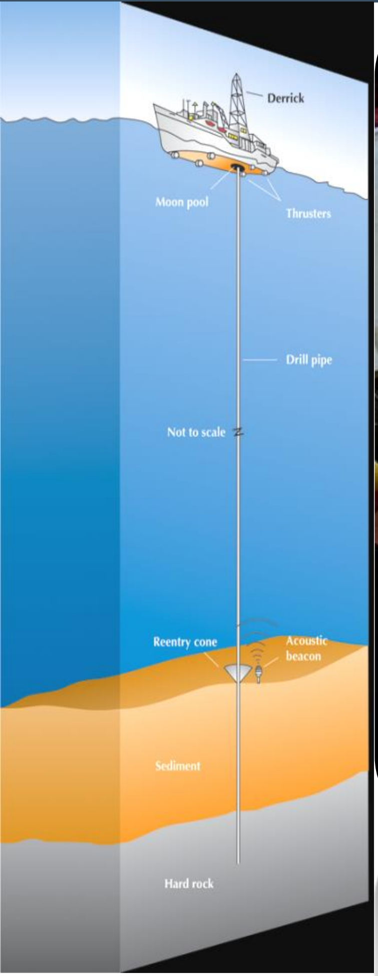
1: Where and why to go to when you want to have data



DSDP/ODP/IODP EXPEDITIONS since 1960-ties (“Exploring the Inner Space of Earth”)

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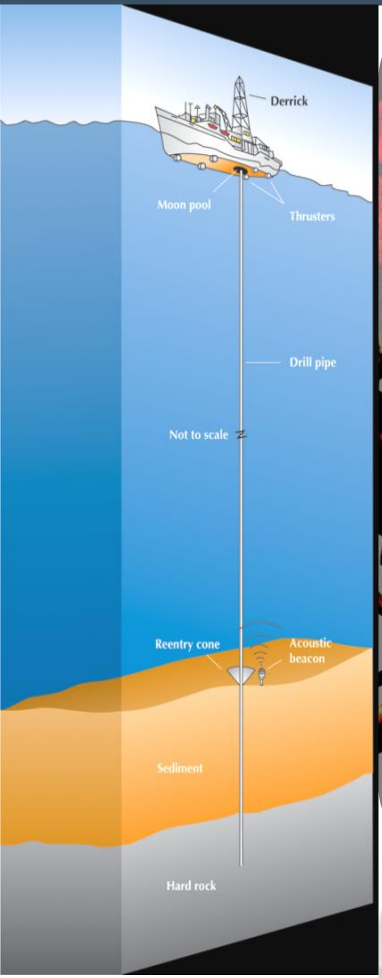

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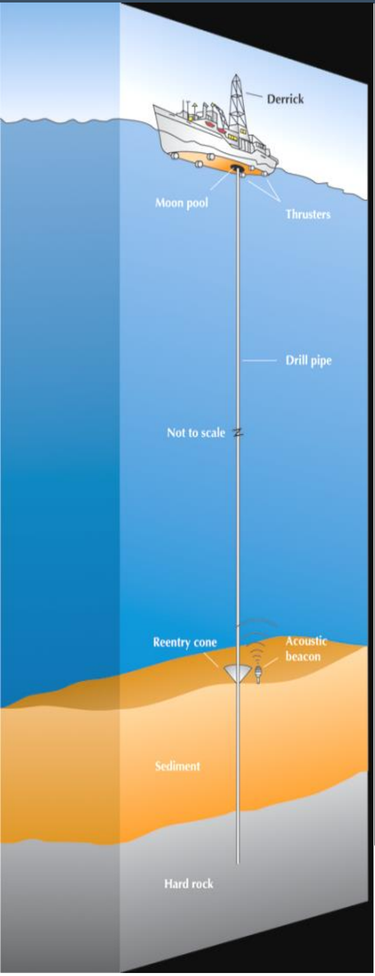

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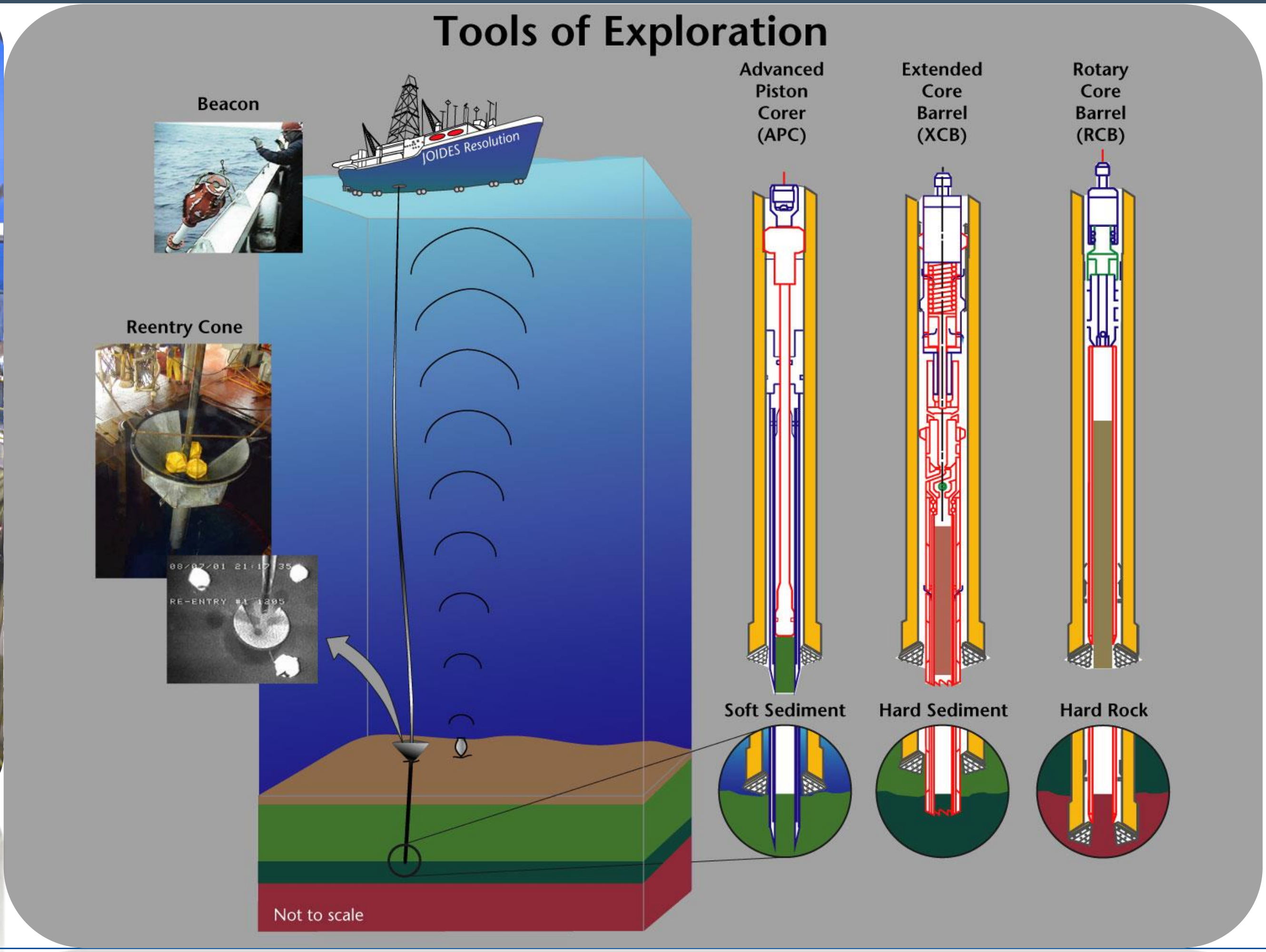

Tools of Exploration

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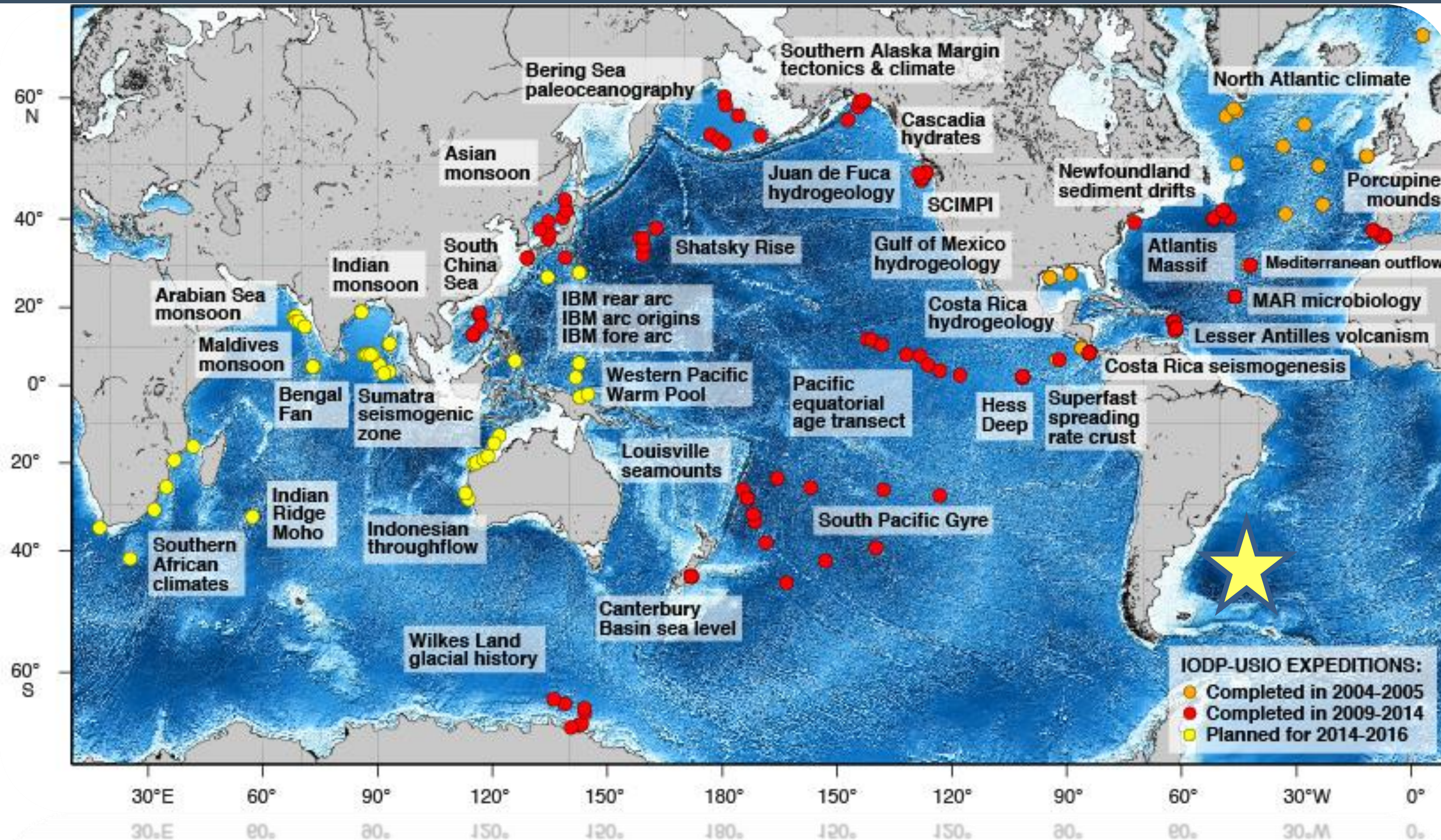
1: Where and why to go to when you want to have data



IODP Cores and Hole Locations around the World

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1: Where and why to go to when you want to have data

- Berlin Spandau
- College Station, TX
- MARUM, Bremen
- Kochi, Japan

Cores stored and preserved in Core Repositories around the World

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1: Where and why to go to when you want to have data

ICDP/ECORD Exploration Platforms: Near-Shore, Lake and Terrestrial

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1: Where and why to go to when you want to have data

ICDP (Terrestrial)

- Long Valley, California, USA
- Hilo, Hawaii, USA
- Koolau, Hawaii, USA
- Chicxulub, Mexico
- Donghai, PR China
- Unzen, Japan
- Mallik, NWT, Canada
- KTB-Hydraulic, Germany
- SAFOD, Parkfield, California, USA
- Chelungpu, Taiwan
- Dead Sea, Israel
- Lake Malawi, Malawi
- Lake Bosumtwi, Ghana
- Lake Qinghai, China
- Chesapeake Bay, Virginia, USA
- Lake Peten Itza, Guatemala
- FAR-DEEP in Karelia, Russia
- IDDP/IDDP2, Iceland
- Lake Potrok Aike, Argentina
- Lake El`gygytgyn, Russia
- Lake Van, Turkey
- Snake River (HOTSPOT), Idaho, USA
- Barberton I, South Africa
- Northern Anatolian Fault Zone, Turkey
- Campi Flegrei, Italy
- Lake Ohrid, Macedonia
- East African Rift, Kenya
- Colorado Plateau, Colorado, USA
- Fennoscandia (COSC), Scandinavia
- Alpine Fault Zone, New Zealand
- Lake Towuti, Indonesia
- Lake Junín, Peru

ECORD (Oceanic)

- Arctic Coring Expedition (ACEX)
- Tahiti Sea Level Change
- New Jersey Shallow Shelf, USA
- Great Barrier Reef, Australia
- Bighorn Basin, Wyoming, USA
- Baltic Sea Expedition

Previous ICDP Projects

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1: Where and why to go to when you want to have data

ICDP(Terrestrial)-LONG VALLEY, CA, 1998

- core imaging
- core archive
- lithological description
- XRD analysis
- thin section analysis
- gas measurements
- mud and drilling parameter
- daily drilling report

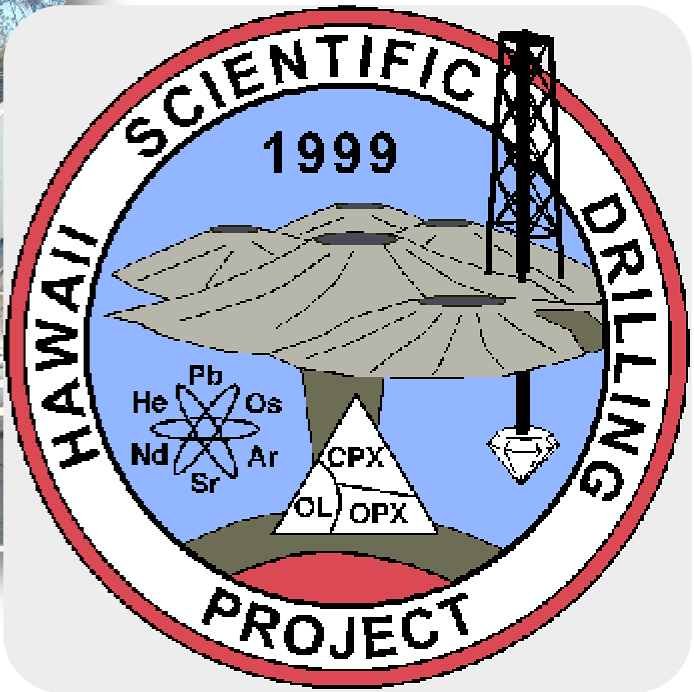
Previous ICDP Projects: Lessons learned

ICDP Training 2016

1: Where and why to go to when you want to have data

ICDP (Terrestrial)–Big Island, Hawaii, 1999

- core imaging
- core archive
- sample archive
- lithological description
- borehole measurements
- mud and drilling parameter
- daily drilling report



Previous ICDP Projects: Lessons learned

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1: Where and why to go to when you want to have data

History – Lessons Learned

INTERNATIONAL CONTINENTAL SCIENTIFIC DRILLING PROGRAM

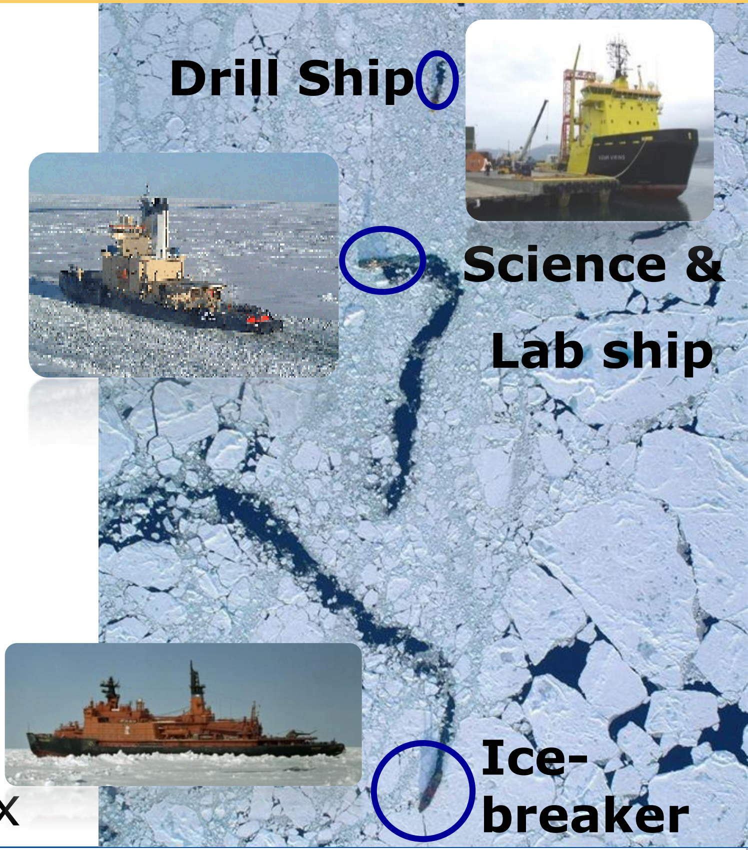
1: Where and why to go to when you want to have data

ICDP (Terrestrial)

FAR-DEEP in Karelia, Russia

ICDP/ECORD (Oceanic)

Arctic Coring EXpedition (ACEX)



ICDP Projects: Very simple to very complex

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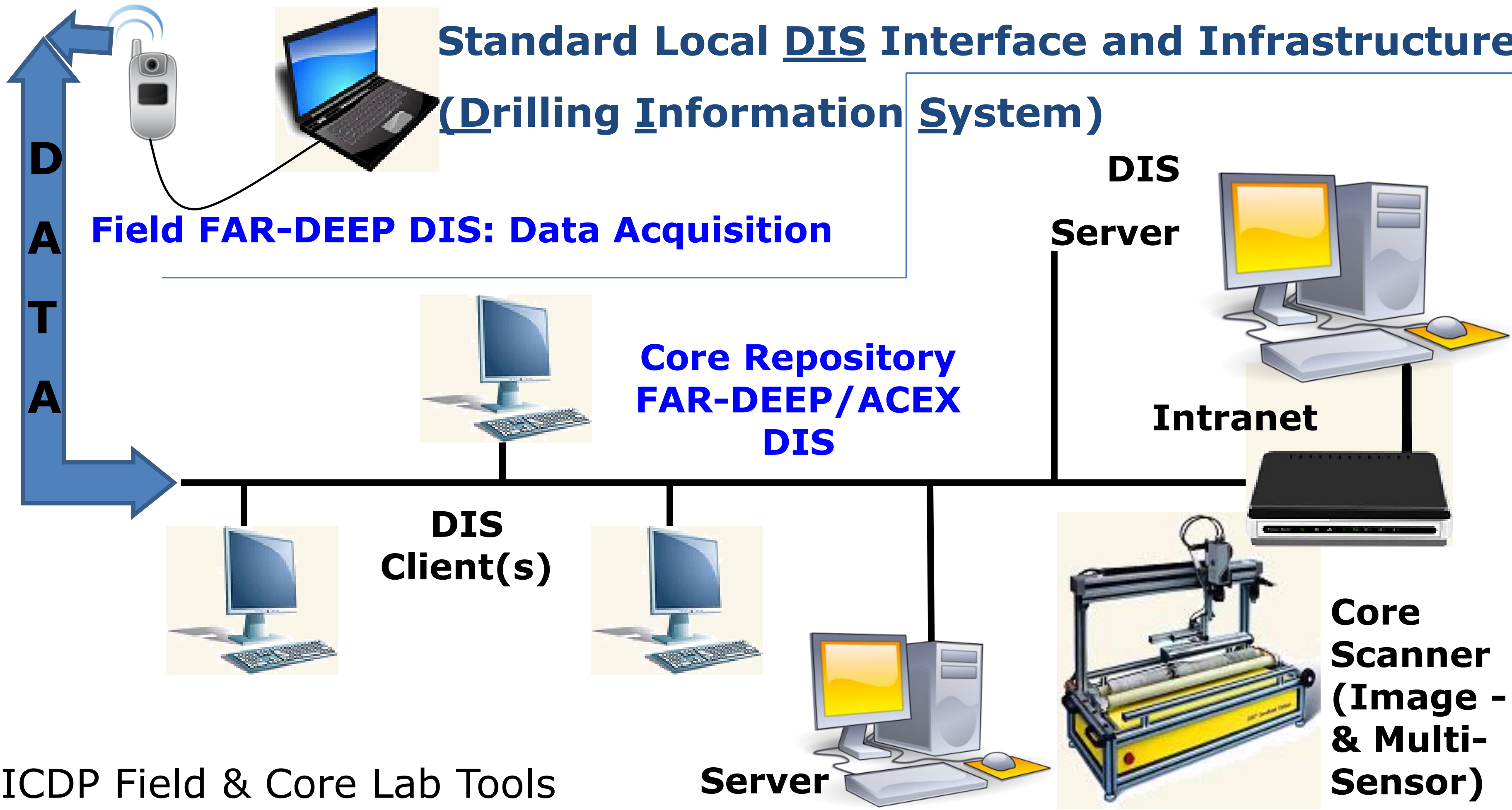
2: What tools to use to make your data work for you

Standard Local DIS Interface and Infrastructure (Drilling Information System)



ICDP Field & Core Lab Tools

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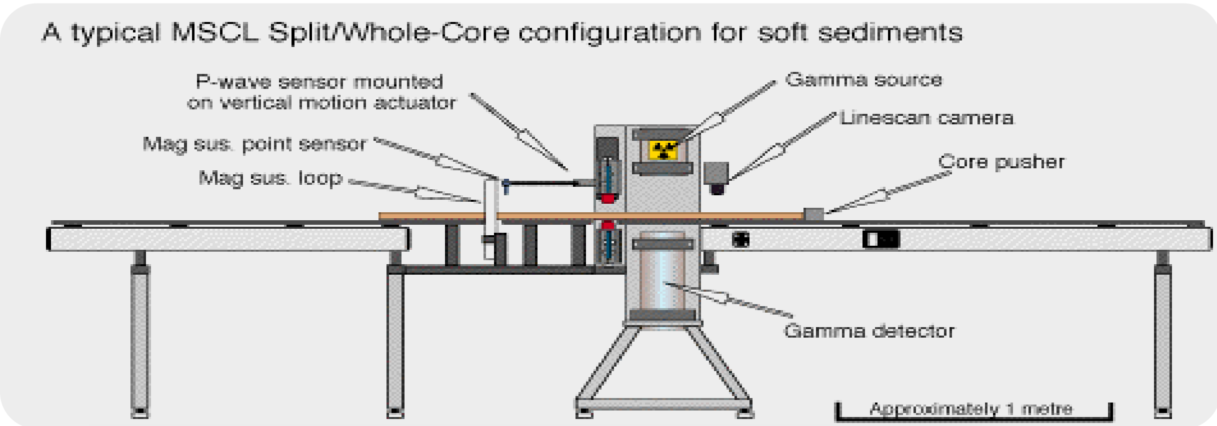
2: What tools to use to make your data work for you

GeoTek Multi Sensor Core Logger (MSCL): DIS-Interfaced



- **Core Diameter Measurements**
- **P-Wave Measurements**
- **Gamma Ray Attenuation (bulk density)**
- **Magnetic Susceptibility**
- **Core Imaging**
- **Natural Gamma Radiation**
- **Electrical Resistivity**

ICDP Core Lab Tools

GeoTek Multi Sensor Core Logger (MSCL): P-Wave Velocity

home mscl sys

GEOTEK

MSCL SENSORS

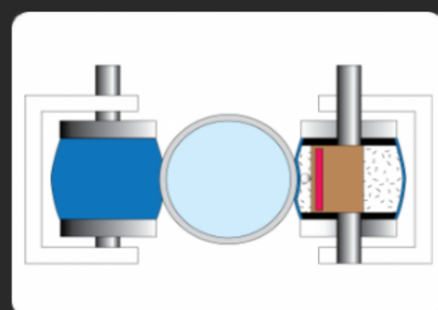
- Gamma Density
- **P-wave Velocity**
- Magnetic Susceptibility
- Non-Contact Resistivity
- Colour Spectrophotometry
- Geoscan V Linescan Imaging
- Natural Gamma Spectrometry
- Near-Infrared/Visible Spectrophotometry
- X-ray Fluorescence

Description

The ARC transducer uses a stationary active transducer element which is made from a 1-3 Polymer Composite, in which the PZT material comprises a forest of narrow longitudinal rods embedded in a polymer. This material combines high coupling with relatively low acoustic impedance.

The transducer takes full advantage of these properties by including a front coupling layer and multi-layer composite backing to suppress unwanted internal ringing and back radiation. This multi-layer composite backing provides good acoustic loading and very high return losses, resulting in a unit with no detectable spurious internal modes and an extremely high back-to-front ratio (in excess of 60 dB).

The stationary composite element is surrounded by oil and a rotating soft deformable diaphragm. This arrangement enables the complete transducer assembly to rotate as the core is passed through the spring loaded opposing transducer pair. The careful internal design provides radiussed internal locating lips which gives a wide contact area and positive repeatable location of the transducers over core diameters within the range of 50mm to 150mm.



Rolling Transducers Cross Section

The centre frequency is 230 kHz, and the design achieves a Q-factor of lower than 3.5 as a result of the inherent material properties combined with careful attention to the mounting and matching. The sound beam is collimated by near field effects to core diameters of 100mm.

The high S/N (signal to noise) ratio resulting from the use of the lower frequency and good coupling, combined with the wide bandwidth, mean that precise repeatable timing measurements can be made, and they offer the option of further pulse processing in the frequency domain.

Other frequency ranges can be made to order.

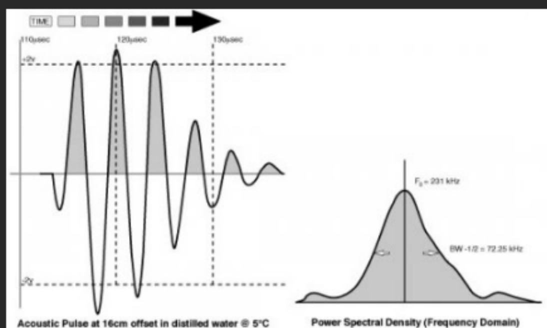
http://www.geotek.co.uk/

2: What tools to use to make your data work for you

GeoTek Multi Sensor Core Logger (MSCL): Acoustics

Key features/Advantages

- The dry coupling removes the necessity and inconvenience of using coupling fluids which eliminates data dropouts caused by operator error.
- A large contact area and lower frequency provide improved S/N enabling accurate velocity measurement even through coarse sand.
- Consistant coupling together with wider bandwidth and pulse characteristics enables meaningful sediment characterisation from spectral analysis.



Rolling Transducers Charts

For further information please contact us.

‹ Gamma Density | up | Magnetic Susceptib

http://www.geotek.co.uk/

Dr. Laurie Linnett, Forthkey Inc., Edinburgh, Scotland (Nov.2003)

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2: What tools to use to make your data work for you

GeoTek Multi Sensor Core Logger (MSCL): Magnetic Susceptibility

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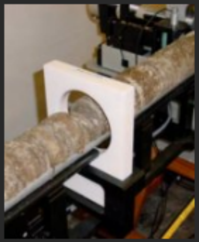
GEOTEK

MSCL SENSORS
- Gamma Density
- P-wave Velocity
- **Magnetic Susceptibility**
- Non-Contact Resistivity
- Colour Spectrophotometry
- Geoscan V Linescan Imaging
- Natural Gamma Spectrometry
- Near-Infrared/Visible Spectrophotometry
- X-ray Fluorescence

Magnetic Susceptibilit

Background
Magnetic susceptibility is the degree of ma
If magnetic susceptibility is positive then t
antiferromagnetic. In this case the magnet
Alternatively, if magnetic susceptibility is n
is weakened in the presence of the materi

Operating Principles:
An oscillator circuit in the sensor produces
magnetic field (0.565 kHz for the MS2C se
vicinity of the sensor, that has a magnetic s
electronics convert this pulsed frequency i



Loop Sensor:
The Bartington l
for magnetic sus
of internal diam
way that no mag
maximum resolu
ratio should be a
degradation ma
desirable. A wid
core diameter to
loops.

Point Sensor:
The Bartington point sensor (MS2E) is mounted on an arm that allows the sensor to be placed on the core surface for each measurement. It uses the same electronics as the loop sensor. Note that the original point sensor (MS2F) required an interface box that is placed in the line from the sensor to the MS3 electronics. The point sensor gives much higher spatial resolution that the loop sensor but is less sensitive. Its field of influence is about 1 cm in diameter and so it cannot be used on whole cores.

Calibration and Processing:
The magnetic susceptibility sensor is electronically set to measure a single standard sample of a stable iron oxide which has been tested and analysed by the manufacturer (Bartington Instruments Ltd). Therefore, all magnetic susceptibility sensors supplied should record exactly the same value for any given sample, and that value should be the same as a measurement made on a different measuring system. In that sense the magnetic susceptibility system is calibrated absolutely. Since the calibration has been set electronically it should not alter. A calibration sample is provided which can be used to check the long term consistency of the calibration. The data obtained from the magnetic susceptibility system provides uncorrected, volume specific magnetic susceptibility, which can be converted to either corrected volume specific magnetic susceptibility or mass specific magnetic susceptibility automatically in the Geotek MSCL software.

Applications:
Changes in magnetic susceptibility correlate with changes in sedimentary provenance and/or diagenetic environment. Magnetic susceptibility records are frequently used for inter-core correlation.

Sensor Manufacturer:
Bartington Instruments (http://www.bartington.com/)

2: What tools to use to make your data work for you

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GEOTEK

MSCL SENSORS

- Gamma Density
- P-wave Velocity
- Magnetic Susceptibility
- Non-Contact Resistivity
- Colour Spectrophotometry
- Geoscan V Linescan Imaging
- Natural Gamma Spectrometry
- Near-Infrared/Visible Spectrophotometry
- X-ray Fluorescence

Gamma Rays:

Photons of light of very short wavelength and high frequency

Gamma Density

Background

The density (ρ) of a material is a measure of how tightly the matter
by the ratio of its mass (m) to its volume (V). Its SI units are kilogra
sometimes given in the cgs units of grams per cubic centimetre (g

Bulk density is a property of powders, granular and multi-phase m
soils and sediments. It is defined as the mass of any particles of th
occupy. The total volume includes particle volume, inter-particle v
density of soils and sediments depends greatly on their mineral m
as a result bulk density can change as a result of handling. Bulk d
gravimetric and volumetric techniques so to differentiate the meas
gamma density is used. The measurement can also referred to as
evaluator).

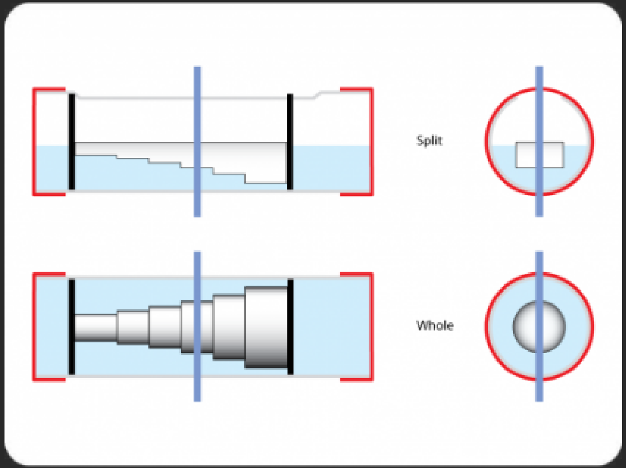
Operating Principle

A gamma ray source and detector are mounted across the core o
centre of the core. A narrow beam of collimated gamma rays is em
energies principally at 0.662 MeV. These photons pass through th
At this energy level the primary mechanism for the attenuation of g
incident photons are scattered by the electrons in the core with a p
therefore, is directly related to the number of electrons in the gamm
density). By measuring the number of transmitted gamma photons
the density of the core material can be determined.

To differentiate between scattered and transmitted photons the ga
photons that have the same principal energy of the source. To do
the region of interest around 0.662 MeV.

Calibration and Processing

The simplest and most reliable method for the calibration and calculation of gamma density is to use an empirical approach which has been shown to provide excellent results. The technique relies on calibrating the system using both the liner in which the core is contained and the fluid which the sediment contains. For example; when using a whole core with water saturated sediments a calibration section should be made which consists of a cylindrical piece of aluminium of varying thickness surrounded completely by water in a sealed liner. For a dry core the calibration should be done with aluminium in a dry half liner.



Porosity can be calculated directly from gamma density if the following is known or can be sensibly assumed:

- the sediment is fully saturated (this can be water, air or any other fluid)
- mineral grain density
- fluid density

Applications

Gamma density data can provide a precise and high resolution record of bulk density, an indicator of lithology and porosity changes. The records are frequently used for core to core correlation. Another important application is the calculation of acoustic impedance and construction of synthetic seismograms.

IODP/ICDP Core Lab Tools

Natural Gamma Radiation

NGR Information provided by David J. Houpt (IODP) for ICDP Training Course, GFZ-Potsdam, October 2016

PPTX: NGR_logger_academy_DJH_20161015
(Time-permitting share Slide#1-17)

Core Scanning (cont.):

Obtaining Physical Property data and

Line-Scan Images

ICDP Core Lab Tools

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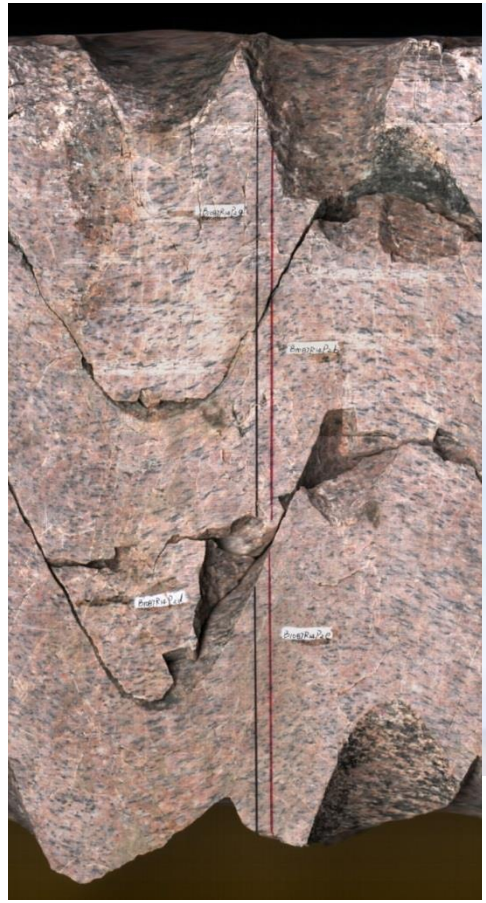
2: What tools to use to make your data work for you

Core Images: "Unrolled" (Whole-Round) Core Scans



DMT CoreScan³

2: What tools to use to make your data work for you

ICDP Splitting of Cores:

A critical working step to get data

2: What tools to use to make your data work for you

ICDP Splitting of Cores: CORE REPOSITORY SPANDAU

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2: What tools to use to make your data work for you

Core Imaging on "Unrolled" -& Split Cores

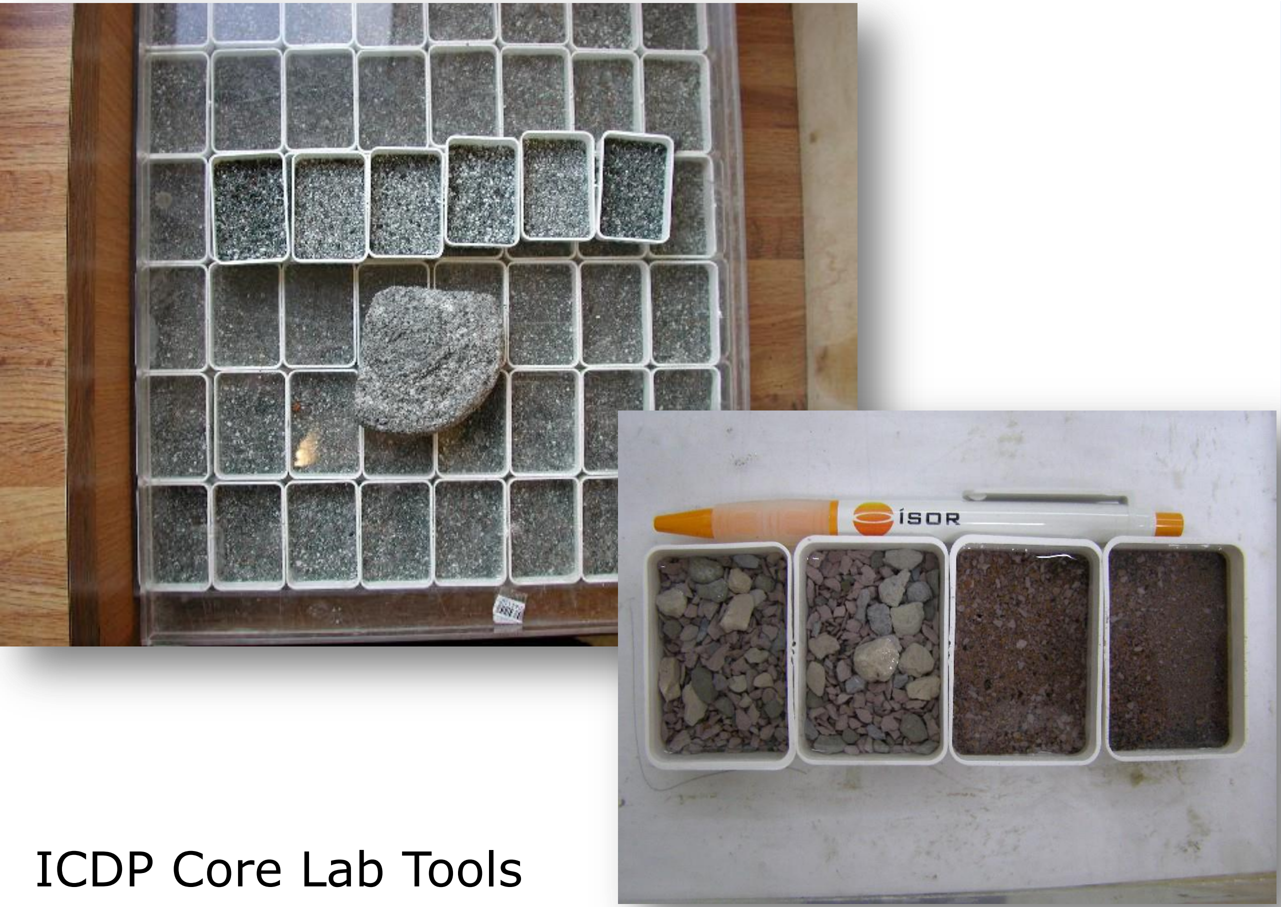
Slabbed Core Scans

Core Box Images

Use new ICDP'S DMT Scanner where possible: Time-efficient and DIS-interfaced!

2: What tools to use to make your data work for you

Core Images: Cuttings in Match Boxes



ICDP Core Lab Tools

DMT CoreScan³

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2: What tools to use to make your data work for you

Physical Properties




IODP Core Lab Tools

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2: What tools to use to make your data work for you

Visual Core Description and Stratigraphic Correlation

IODP Core Lab Tools

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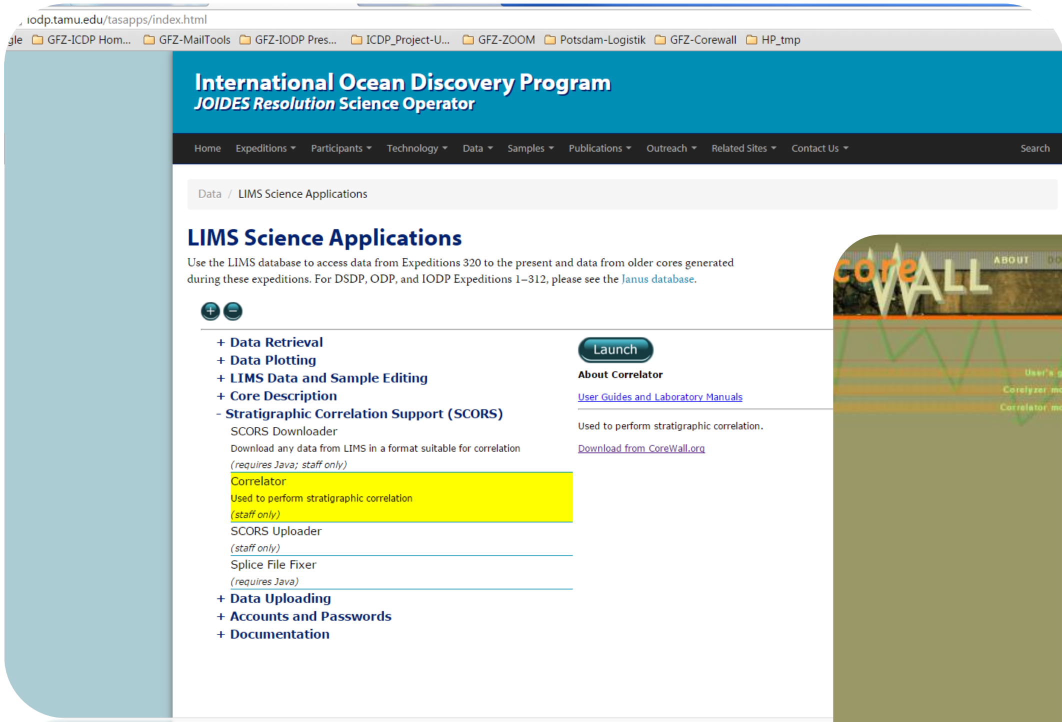
2: What tools to use to make your data work for you

Data-Composing -& Splicing:

CORELYZER &

CORELATOR



IODP/ICDP Core Lab Tools

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2: What tools to use to make your data work for you

Visual Core Description:

CORELYZER

Showcased in Berlin-Spandau Repository in the afternoon!

IODP/ICDP Core Lab Tools

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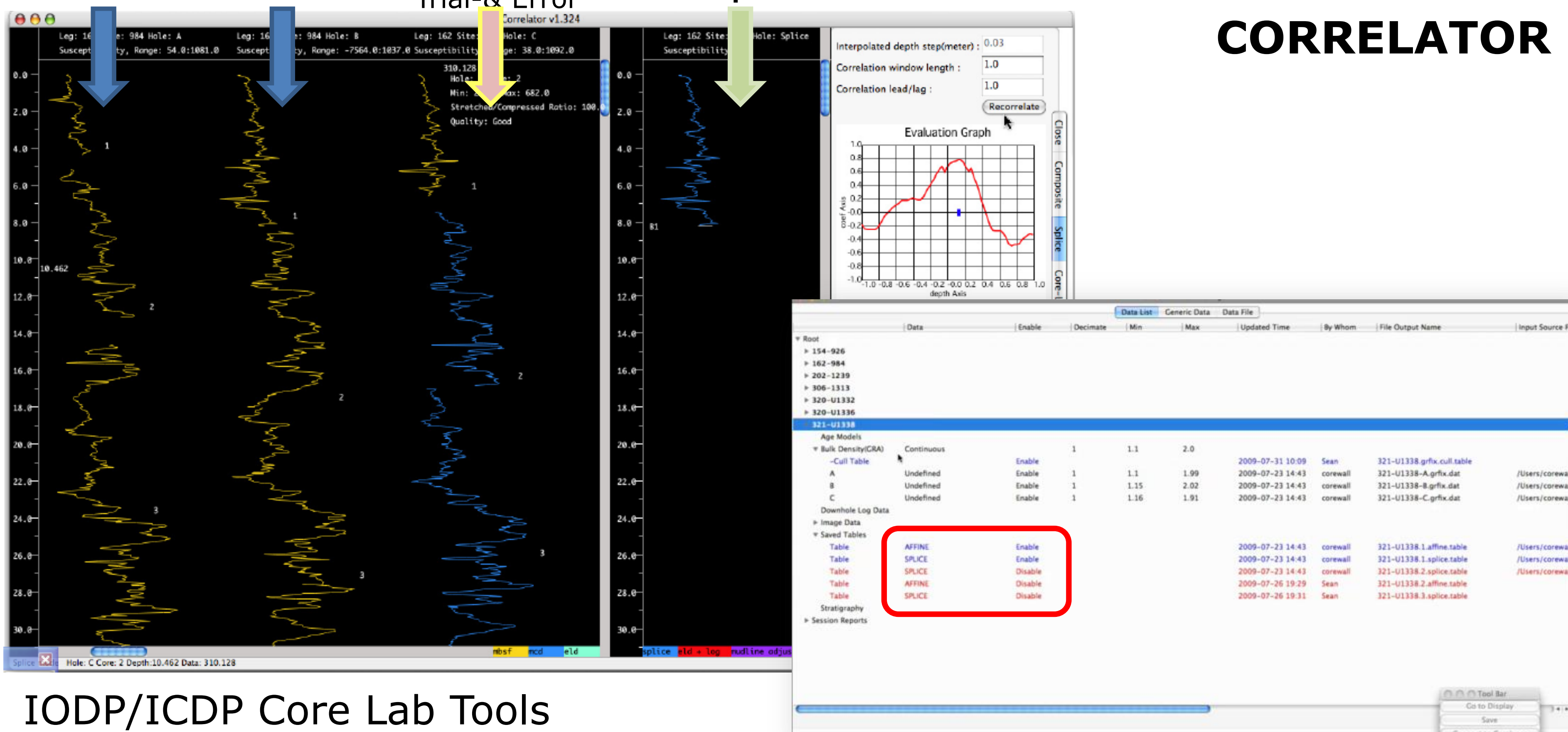
2: What tools to use to make your data work for you

Stratigraphic Correlation:

CORRELATOR

Hole-A Hole-B Depth-Matching Trial-& Error Composite



IODP/ICDP Core Lab Tools

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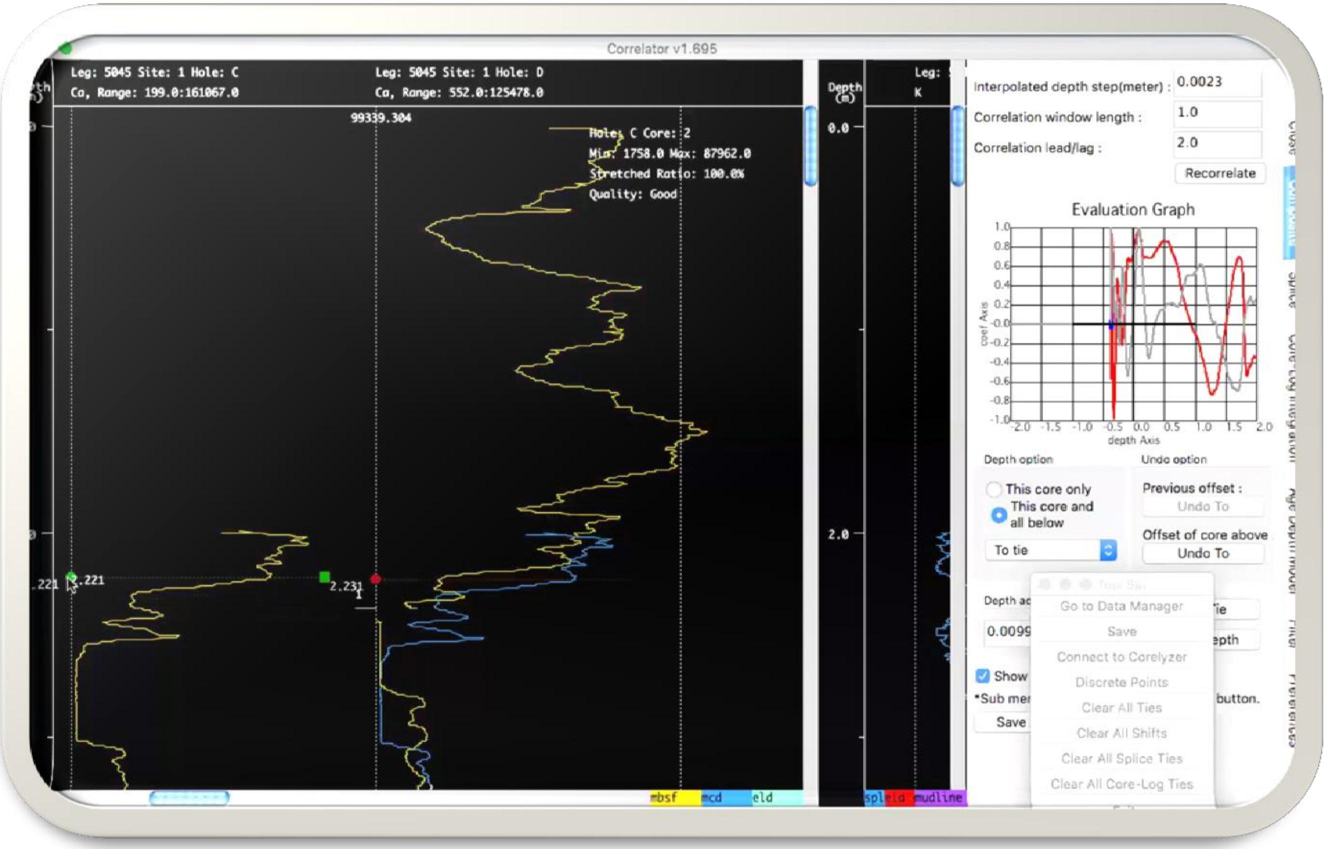
2: What tools to use to make your data work for you

IODP/ICDP

Core Lab Tools

Dr. Alexander Francke, Universität Köln, with a CORRELATOR demo during DIS-Training for ICDP Project Deep CHALLA (Sept.2016)



Supplemental information from Alex's presentation adds value to existing instructional materials.

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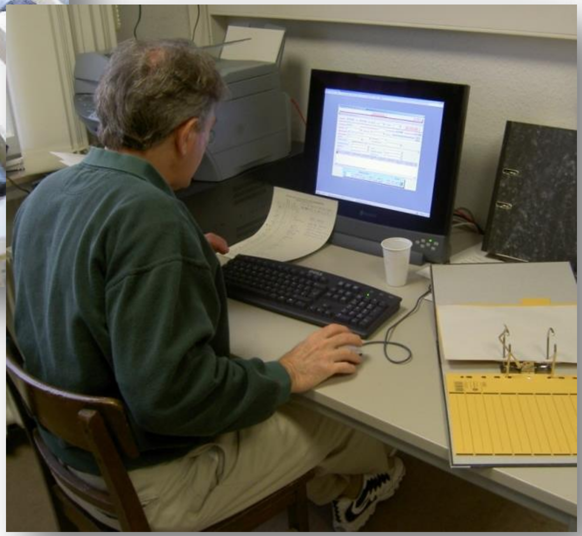
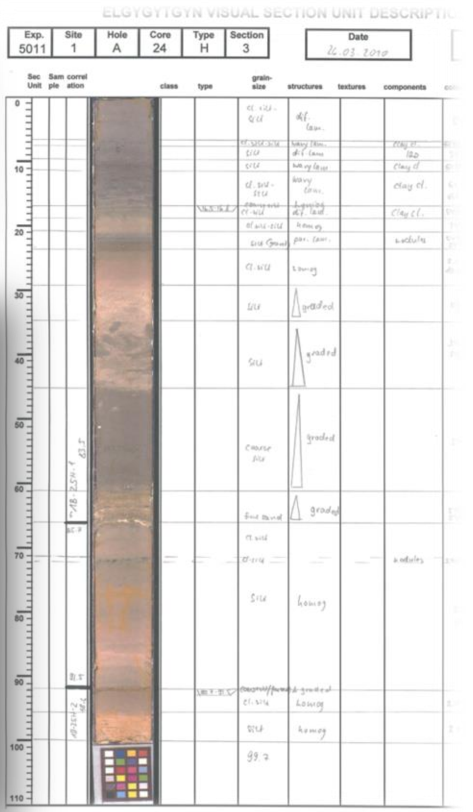
2: What tools to use to make your data work for you

Visual Core Description – ICDP

smart dis

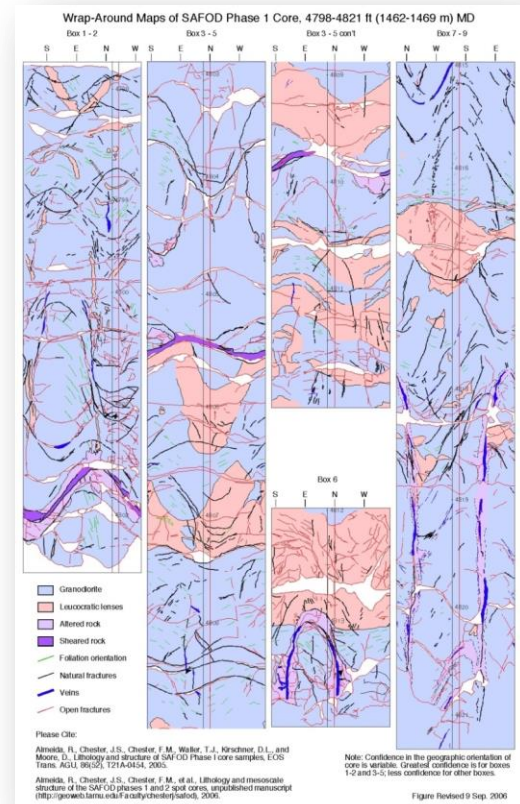




ICDP Core Lab Tools

ICDP Visual Core Description "Gone Crazy":

SAFOD Cores (San Andreas Fault, California, USA)



Let`s continue in 15 minutes ☺

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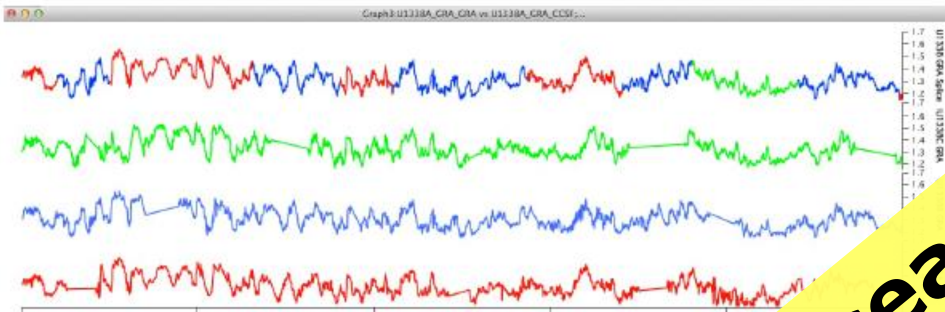
INTERNATIONAL CONTINENTAL SCIENTIFIC DRILLING PROGRAM

3: Quality data – Do you have the basics down?

ODP Macro User Guide

Nov 10, 2013



U1338 GRA data from each hole plus the spliced data wave (top). Colors of th... different splice sections use the "Set as f(z)" option and the Hole_Index...

U1338 hole and splice images with GRA data superimposed. Vertical bars indicate the tops (red) and bottoms (yellow) of intervals used in the splice.

CODD: Code for Ocean Drilling Data

If not: Come to Potsdam!

– and we'll teach you the *Basics*. – How to:

- Download various data from corresponding data bases
- ✓ Clean Physical-Property data
- ✓ Splice and integrate various data sets (PP, Images, Borehole) using

IGOR Pro

coreWall

3: Quality data – Do you have the basics down?

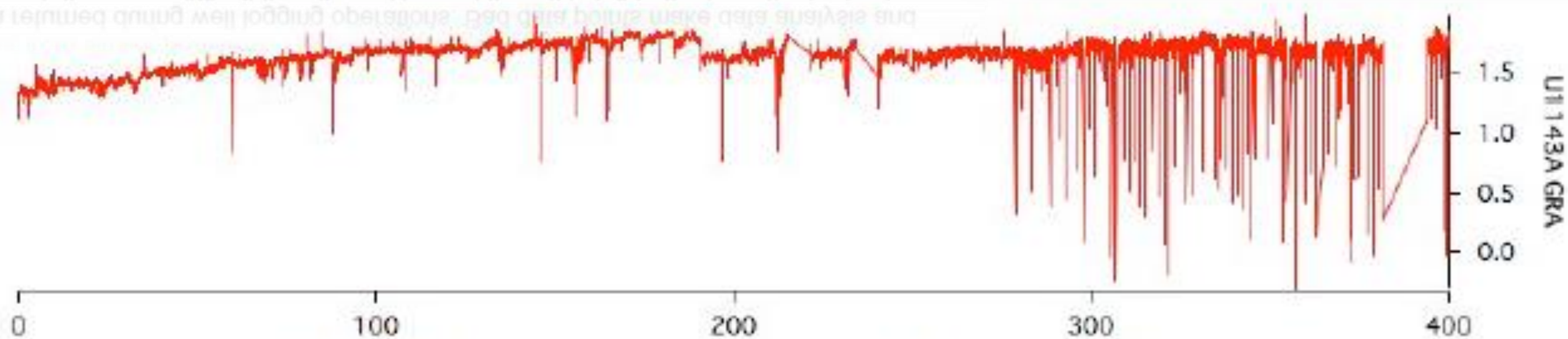
ODP Macro User Guide

Nov 10, 2013

Data Editing

Data acquired using scanning systems such as the core tracks aboard the GLOMAR Challenger and the JOIDES Resolution are indiscriminate in the sense that they do not have a way to evaluate the quality of the core at the point of measurement, and so are prone to collect "bad" data points. Other data collection systems may also suffer from similar problems. For example, hole conditions may invalidate intervals of data returned during well logging operations. Bad data points make data analysis and interpretation more difficult than it need be and thus, it is left to the investigator to clean bad data from raw data output.

IGOR Pro



Raw GRA density data versus depth for Hole U1134A.

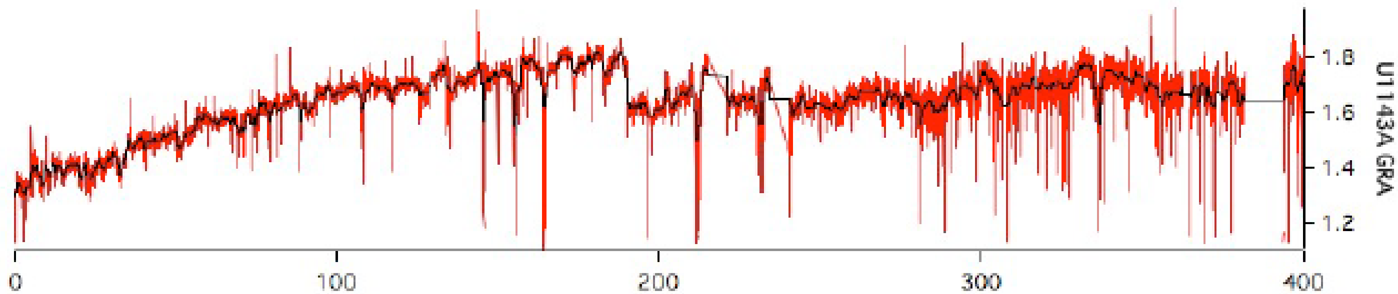
3: Quality data – Do you have the basics down?

DeSpike_Via_Smoothing

While Auto_Edit efficiently replaces points outside a prescribed range with blank values, it has an inherent weakness when used with data that have a large true variation. Our GRA data example increases from values near 1.1 gm/cc near the seafloor to values around 1.8 gm/cc at depth. Density values that are evidently incorrect below 300 m still fall within the acceptable range for shallow depths.

DeSpike_Via_Smoothing addresses this problem by using a smoothed data curve as a reference for eliminating outliers in the data. The process requires several steps:

Step 1. Use the **Smooth** function under the **Analysis** window to create a continuous smooth curve of the data. Plot the smooth curve on top of the data using the depth wave of the data as the X axis.



GRA data with superimposed smoothed curve.

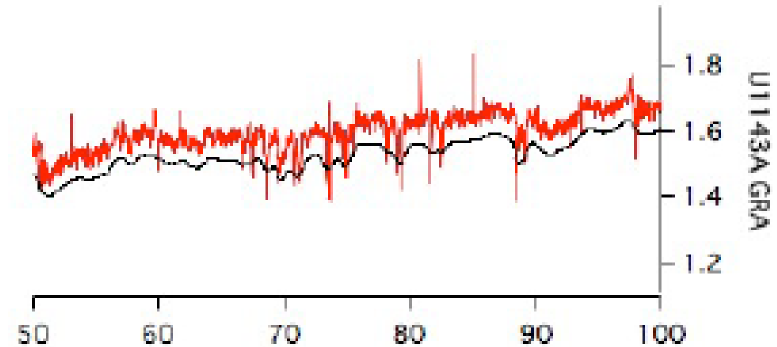
3: Quality data – Do you have the basics down?

Step 2. From the command line, shift the smooth curve up or down so that it defines a boundary between good and bad data.

Step 3. Run DeSpike_Via_Smoothing. Inputs for the macro allow the user to identify the Technique, the smooth curve, and whether the user wants to replace all data above or below the curve. Data points that above/fall below the smooth curve will be replaced by blanks.

- Duplicate/O :U1143_GRA:U1143A_GRA_GRA,U11
- Smooth 501, U1143A_GRA_GRA_smth
- AppendToGraph/R=U1143A_GRA_GRA U1143A_C
- ModifyGraph rgb(U1143A_GRA_GRA_smth)=(0,0,0

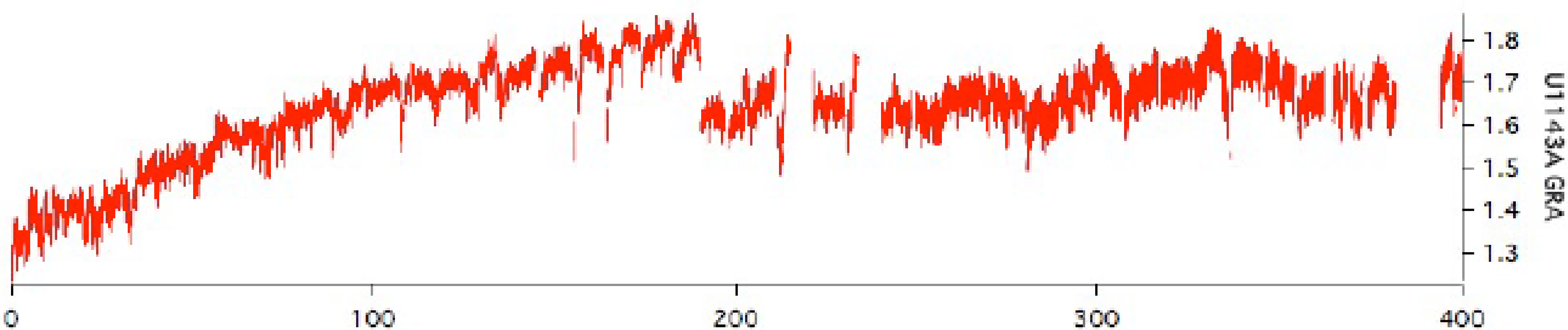
```
U1143A_GRA_GRA_smth-=.07
```



Detail of Data with smooth line shifted

3: Quality data – Do you have the basics down?

Step 4. Shift smooth curve from the command line to the opposite side of the data and run DeSpike_Via_Smoothing again. The data should now be rid of the most obvious spikes and outliers. Where raw data were initially extremely noisy it may be necessary to run a second iteration of DeSpike_Via_Smoothing.



U1143A GRA density data after running Auto_Edit and DeSpike_Via_Smoothing.

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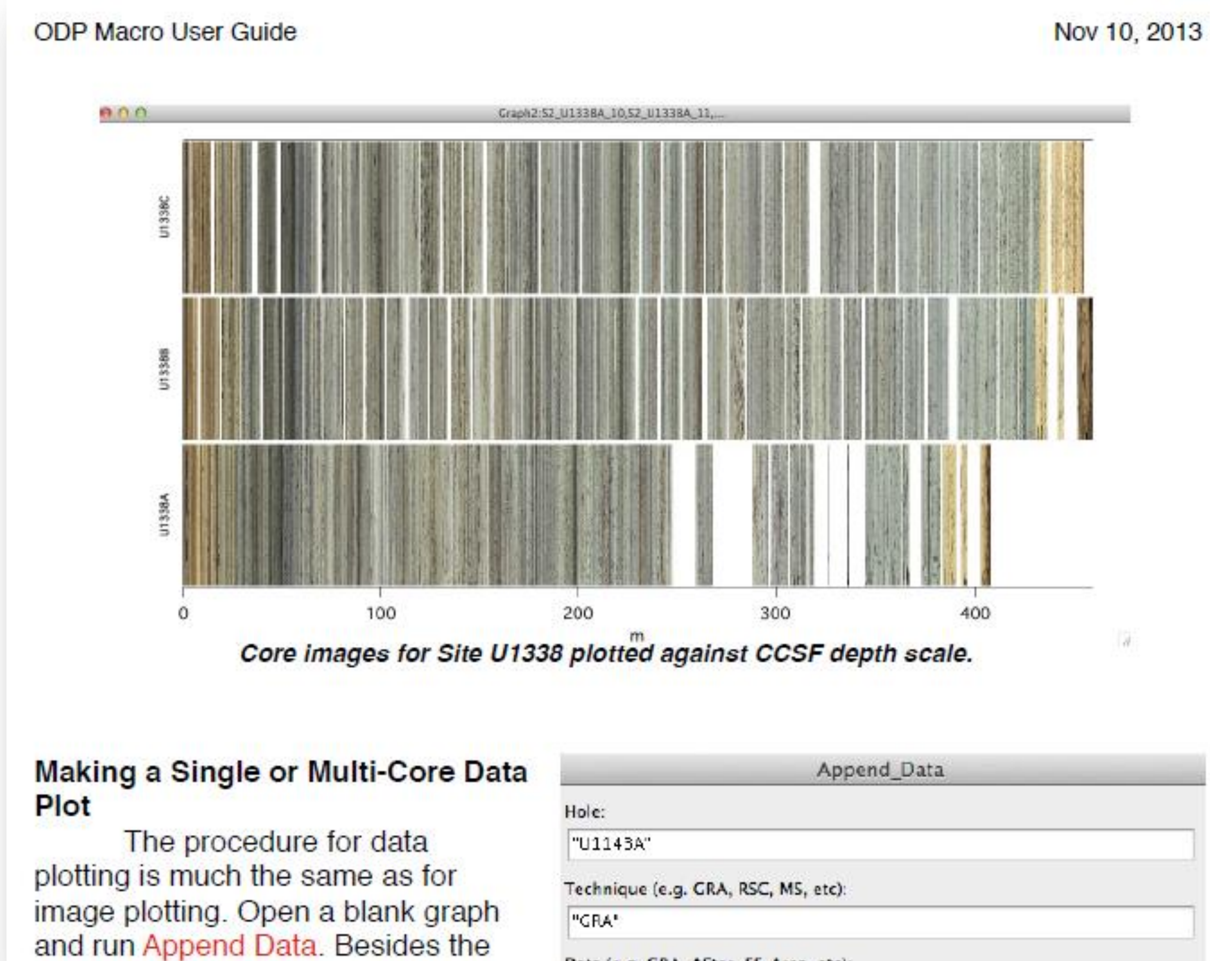
3: Quality data – Do you have the basics down?

- ✓ Core Images: A very critical data component
- ✓ Can be spliced like all other data and thus numerically overlaid with other data (e.g. from Physical Property measurements)



ODP Macro User Guide Nov 10, 2013

Core images for Site U1338 plotted against CCSF depth scale.

Making a Single or Multi-Core Data Plot

The procedure for data plotting is much the same as for image plotting. Open a blank graph and run Append Data. Besides the

Append_Data

Hole:

"U1143A"

Technique (e.g. GRA, RSC, MS, etc):

"GRA"

Data (e.g. GRA, AStar, FE Area, etc):

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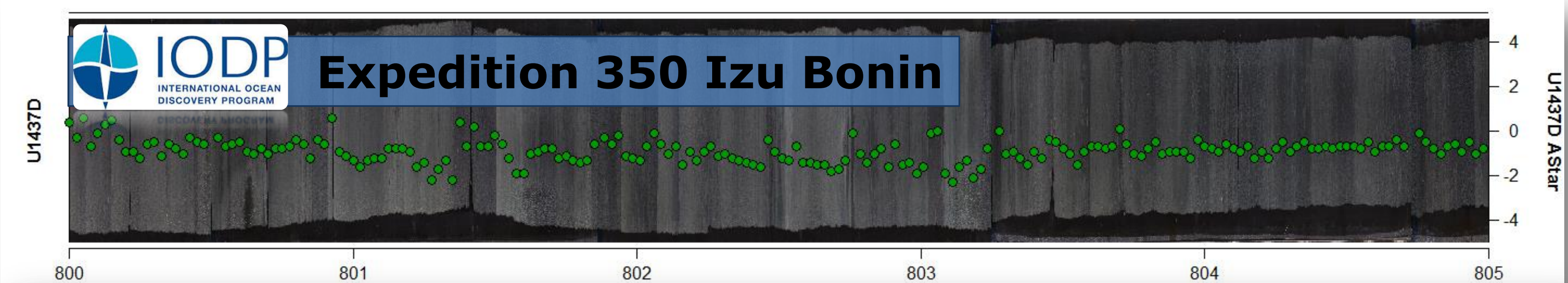
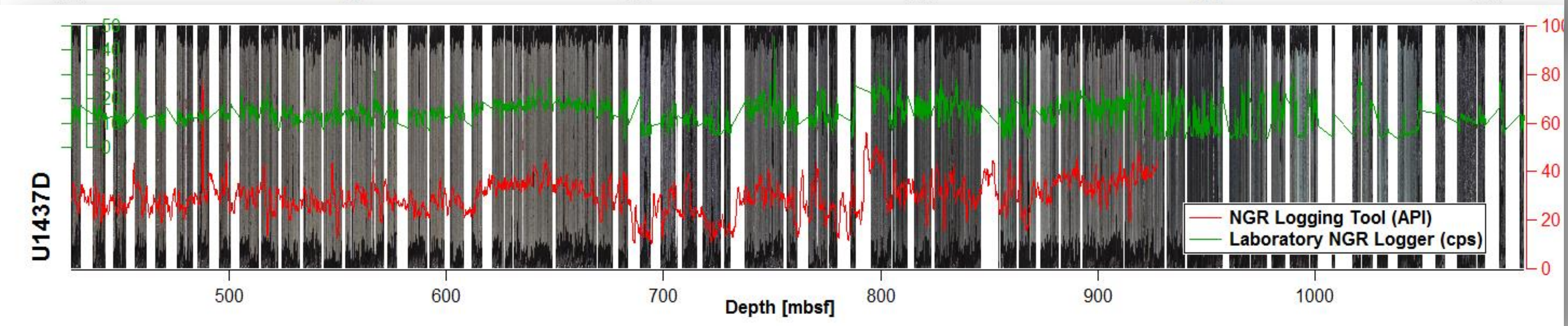
3: Quality data – Do you have the basics down?

✓ Goal and Purpose: Integrate images and other data into one coherent data concept for a better evaluation of the regional geology

Example for CODD: Code for Ocean Drilling Data





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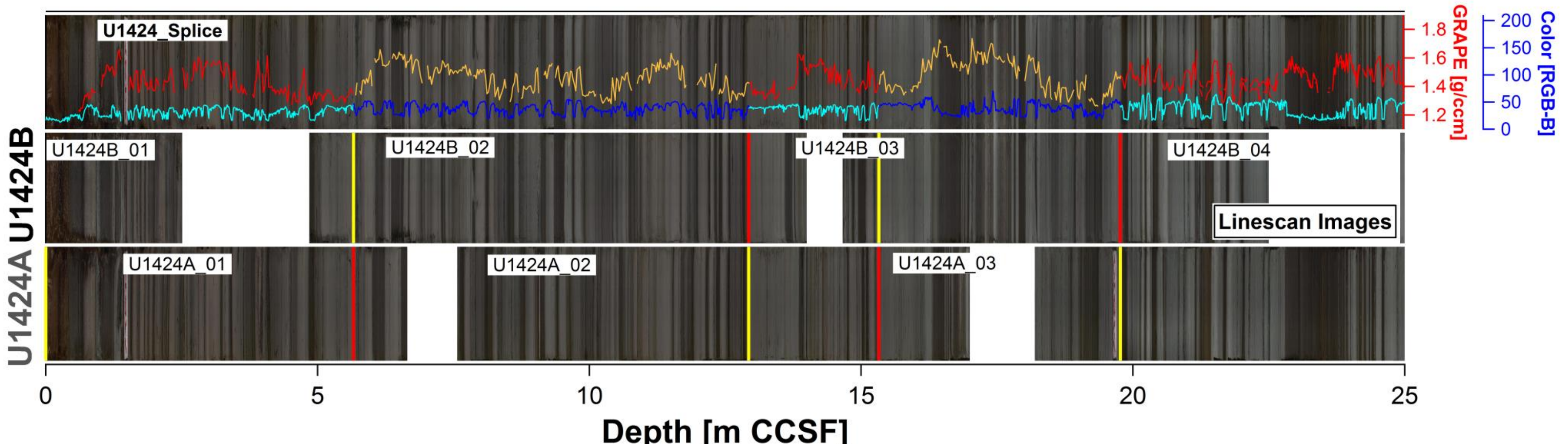
3: Quality data – Do you have the basics down?

✓ Splicing and Depth-Matching of Physical-Property and Line-Scan Images *plus* "Visual Core Description" leads to an enhanced ***Core-Borehole Log Data Integration***



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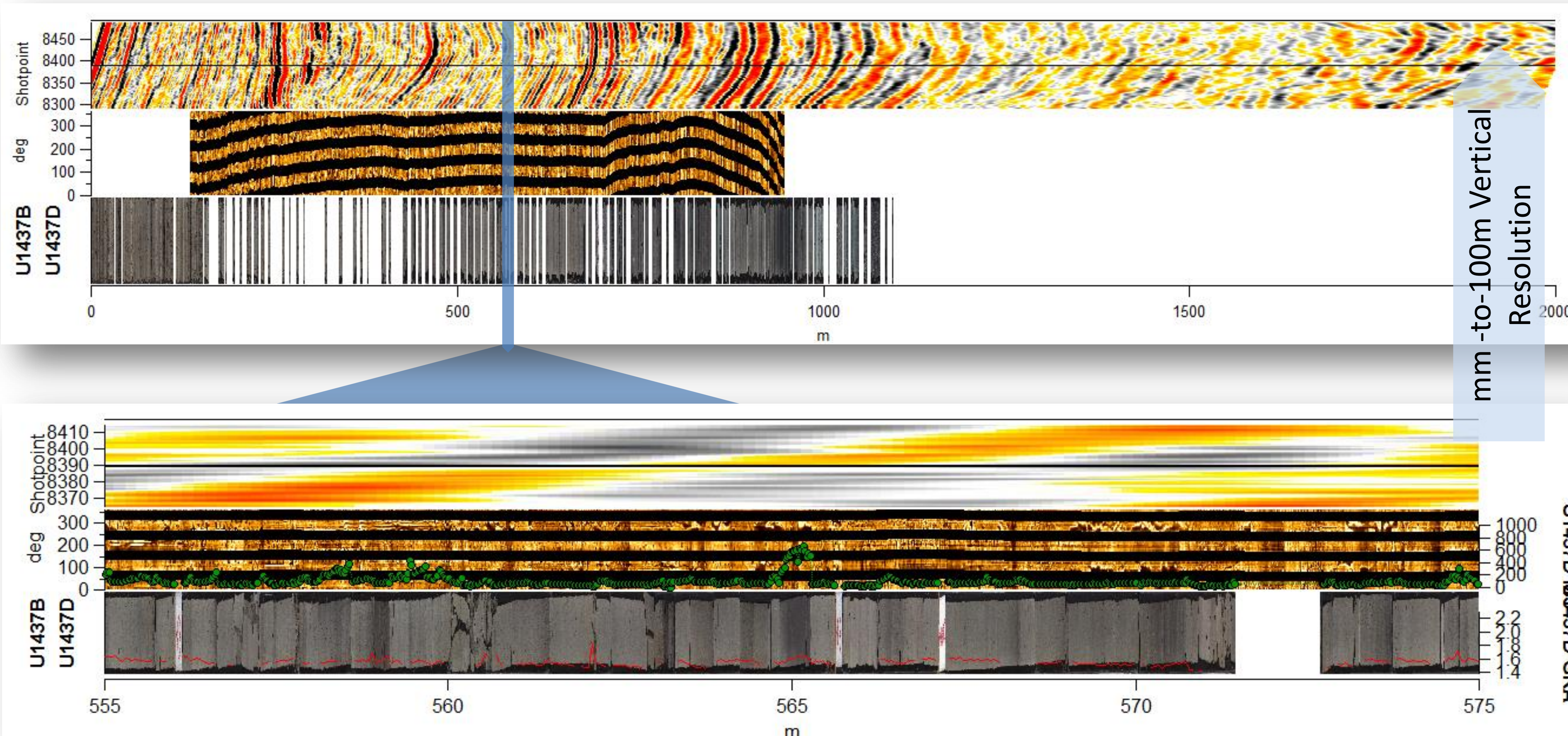
Expedition 346 Asian Monsoon

Example for CODD: Code for Ocean Drilling Data

ICDP Training 2016

4: From one to multiple data sets: Core-Log Integration



Expedition 350 Izu Bonin

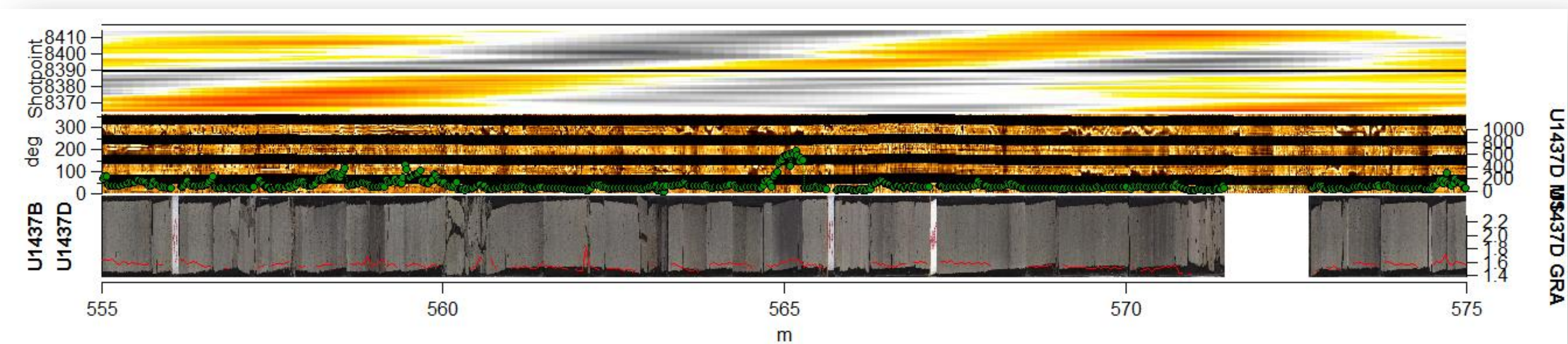
ICDP Training 2016

4: From one to multiple data sets: Core-Log Integration

- **Motivation**: Both academia and industry currently try to improve the interpretation of geophysical data - thus enhancing our understanding of the geology behind geophysical data records and associated processes (e.g. „permeability" and how it influences seismic data)

- **Goal #1**: Obtain consistently high-quality site survey seismic, physical-property and logging data (e.g., Natural Gamma, Magnetic Susceptibility, Bulk Density, etc.) in-situ, borehole and laboratory

- **Goal #2**: Merge multiple data sets into one coherent geological concept



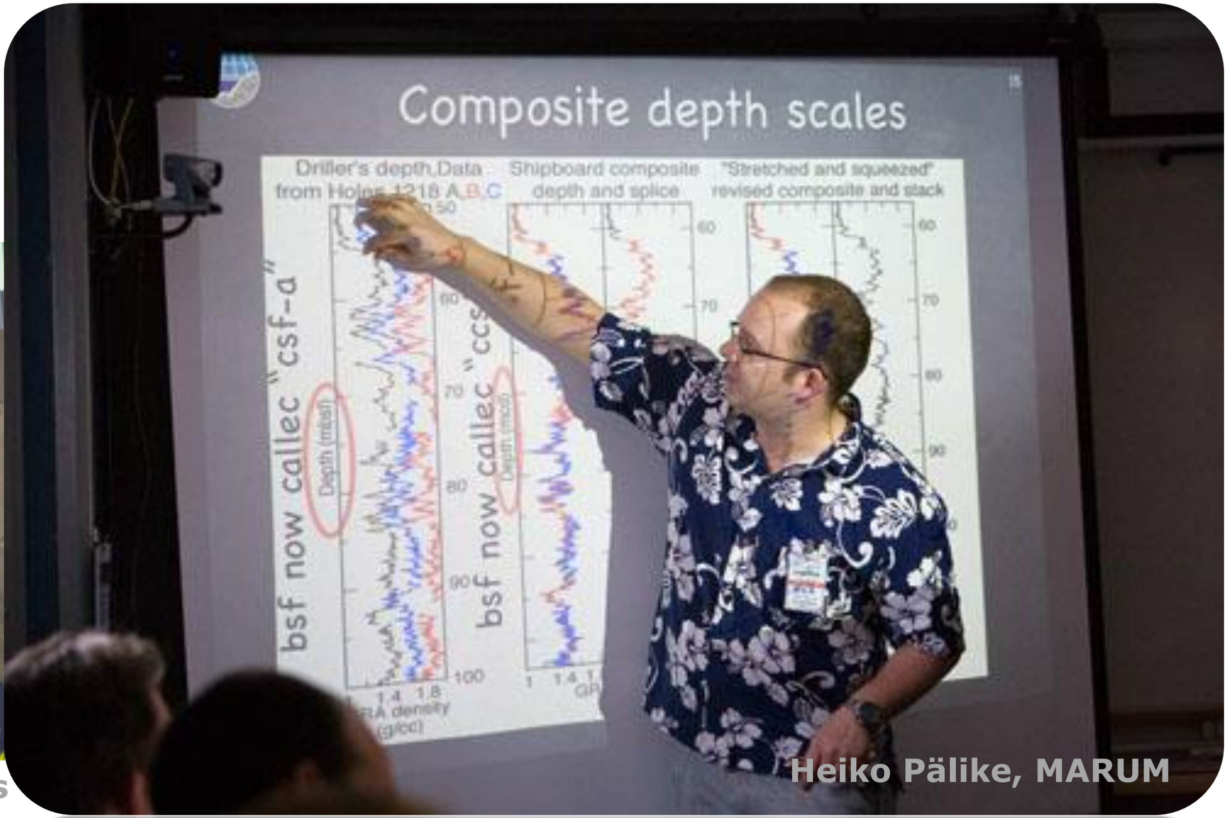
4: From one to multiple data sets: Core-Log Integration

Shipboard/Onshore Science Meetings and Publications: *How to digest it all*

Jörg Geld-macher, GEOMAR

Jon Grout, IODP (retired)

William Sager, University of Texas



Heiko Pälike, MARUM

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5: CODD: Code for Ocean Drilling Data

The Currency of all Science: Publication$

ELSEVIER
Marine Geology 180 (2002) 29–47
MARINE GEOLOGY
INTERNATIONAL JOURNAL OF MARINE GEOLOGY, GEOCHEMISTRY AND GEOPHYSICS
www.elsevier.com/locate/margeo

Sedimentation rates off SW Africa since the late Miocene deciphered from spectral analyses of borehole and GRA bulk density profiles: ODP Sites 1081–1084

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[b] *Office of Naval Research, Code 322 GG, 800 North Quincy Street, Arlington, VA 22217-5660, USA*

Received 1 July 2000; received in revised form 10 December 2000; accepted 27 May 2001

Abstract

Sedimentation rates (SRs) off SW Africa were calculated by performing spectral analyses in the depth domain on borehole and gamma-ray attenuation (GRA) bulk density data from ODP Sites 1081–1084. Inversion and integration of SRs versus depth from spectral analysis yielded detailed SR profiles in the time domain. Our technique allowed the detection of excursions in calculated SRs that not only often differed from those established through coarse-scaled biostratigraphic data, but also revealed a greater regional variability in the sediment accumulation over time. High-resolution bulk density data exhibited distinct periodicity in the waveband of Milankovitch cycles (precession at 19–23 kyr; obliquity at 41 kyr; eccentricity at 100 kyr). The pronounced Milankovitch cyclicity suggests that climate

Published 2002

Revisiting the Ceara Rise, equatorial Atlantic Ocean: isotope stratigraphy of IODP Leg 154

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[2]MARUM, University of Bremen, Bremen, 28359, Germany
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[4]Helmholtz Centre Potsdam, GFZ, Potsdam, 14473, Germany
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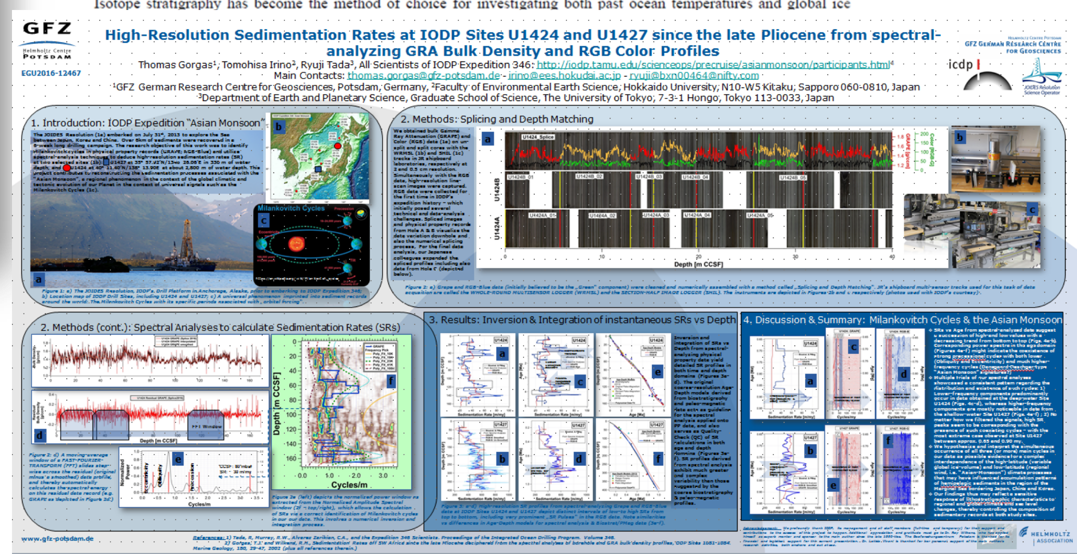
Correspondence to: Roy H. Wilkens (rwilkens@hawaii.edu)

In Review

Abstract

Isotope stratigraphy has become the method of choice for investigating both past ocean temperatures and global ice



AGU 2014/EGU 2016

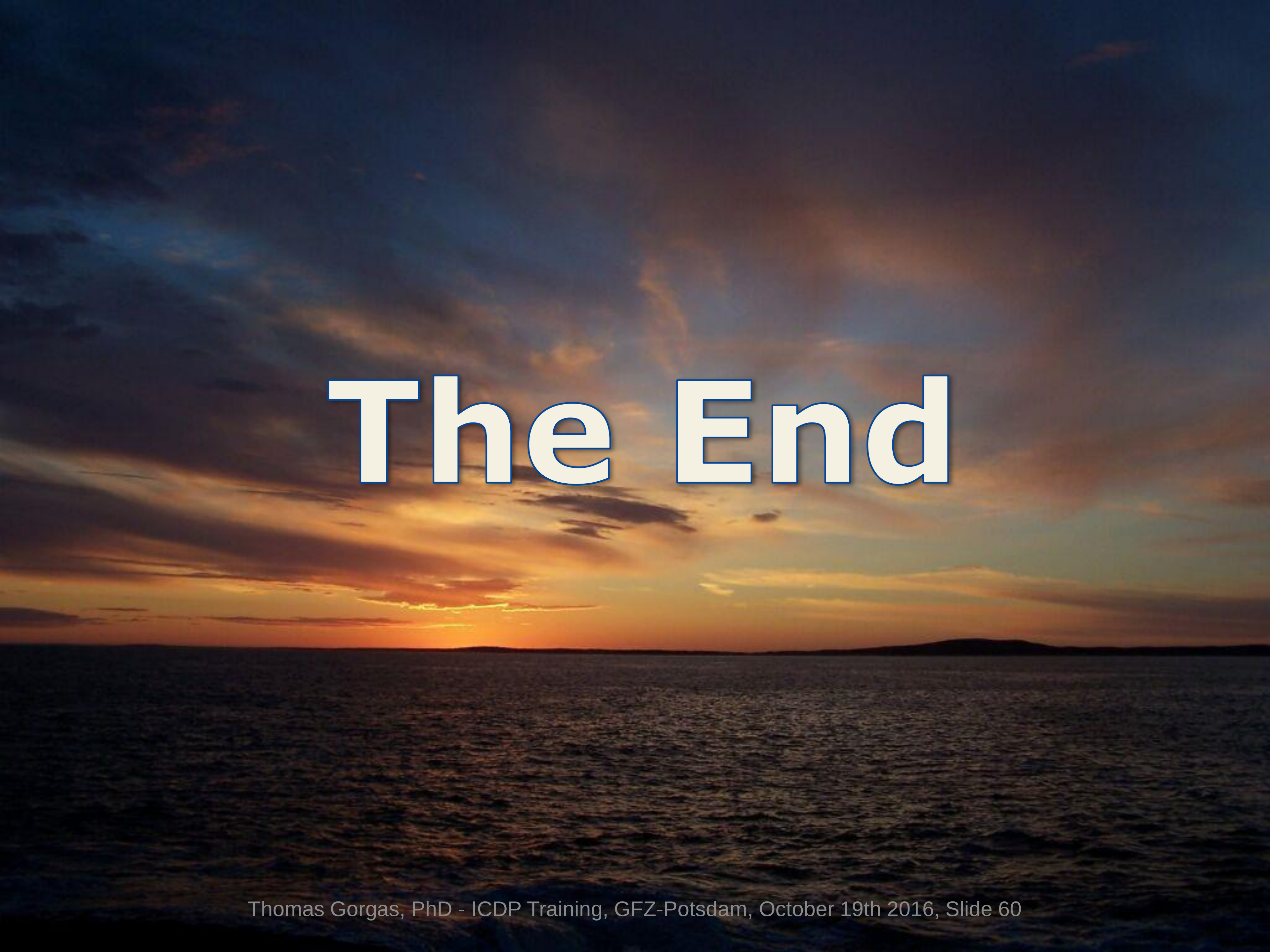
International Presentations

ICDP Training 2016

6: Final Take-Home Message

- **Get involved with International Scientific Drilling Projects (terrestrial, amphibian, ocean) via ICDP -& IODP**
- **Come to Potsdam and get trained on important skills to succeed with your drilling project**
- **Enjoy a great place and adventure with nice colleagues and friends!**

The End



7: Questions?

Need more information on specific topics (NGR, XRF, Core Handling, etc.)?

Please let us know and we can provide more to you.

Provide feedback and stay in touch with us!

8a: More on CORING during a LAKE DRILLING PROJECT...

Share: Slide#1-29 of Franke_Coring.pdf, also refer to Anja Schleicher's presentation on Oct.17th!

8b: More on Natural Gamma Radiation…

TOP Logger Academy

- Expedition 349P
- Natural Gamma Radiation Logger (NGRL), - a.k.a. “The NGR”

IODP
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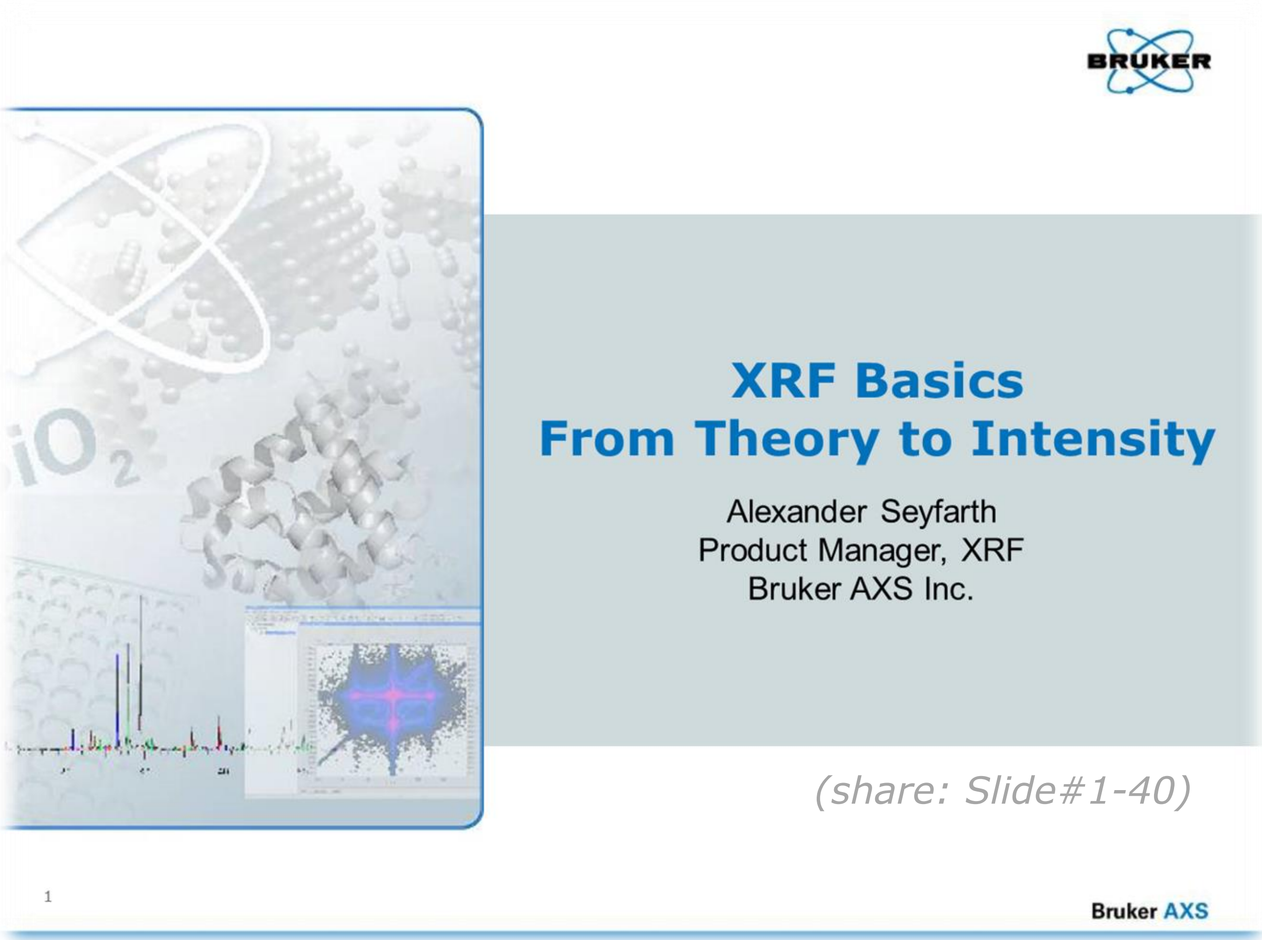
DISCOVERY PROGRAM

Presentation gratefully received from David J. Houpt (IODP) and allowed to presented at the ICDP Training Course, Potsdam, GFZ, October 2016

8c: More on XRF (X-Ray Fluorescence) Analysis...



9a: More on ExpeditionDIS from a current ICDP project

Team Koyna: „Greeting“ (ZOOM Video Conference, October 18th 2016)

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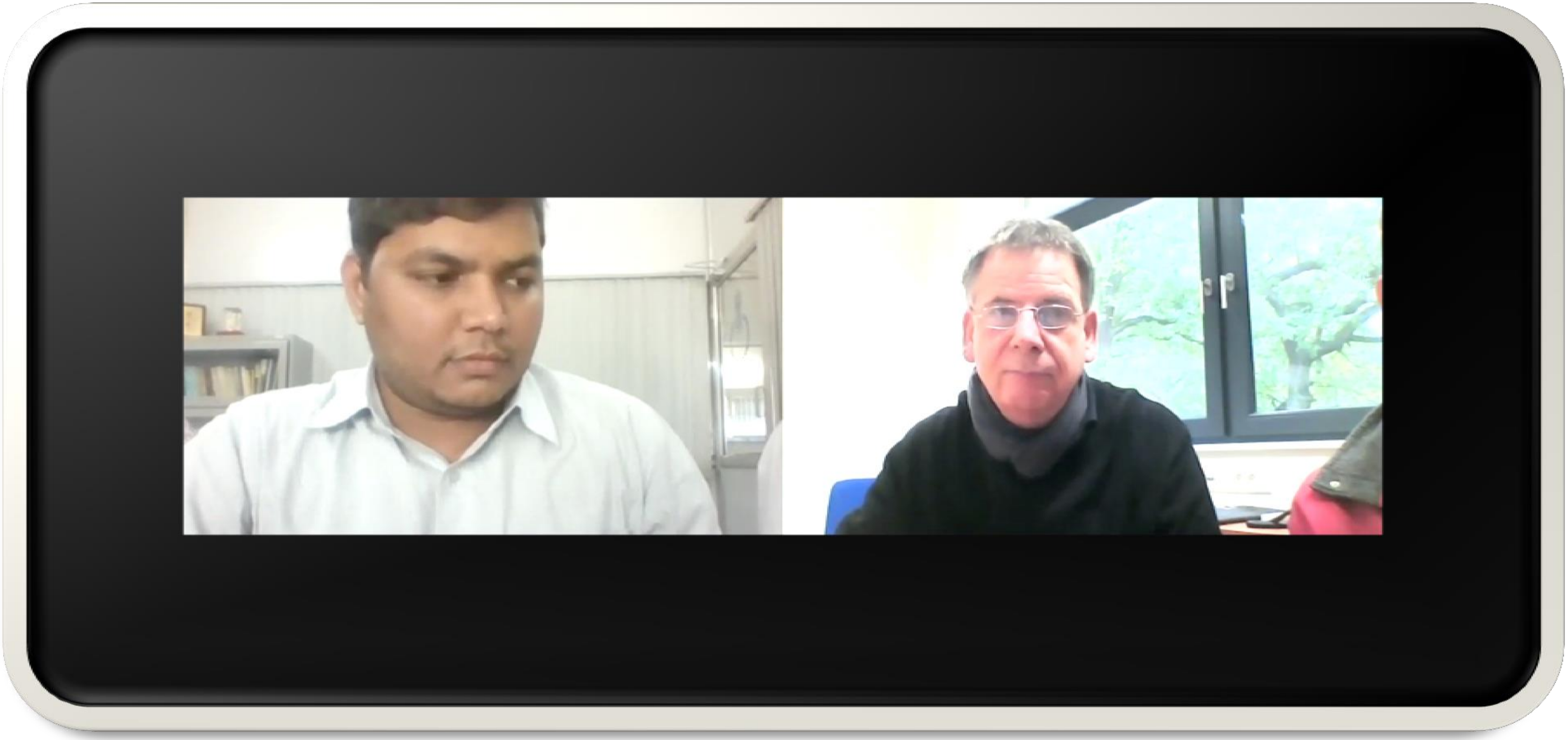
9c: More on ExpeditionDIS from a current ICDP project



Team Koyna: „Project Planning“ (same video conference)

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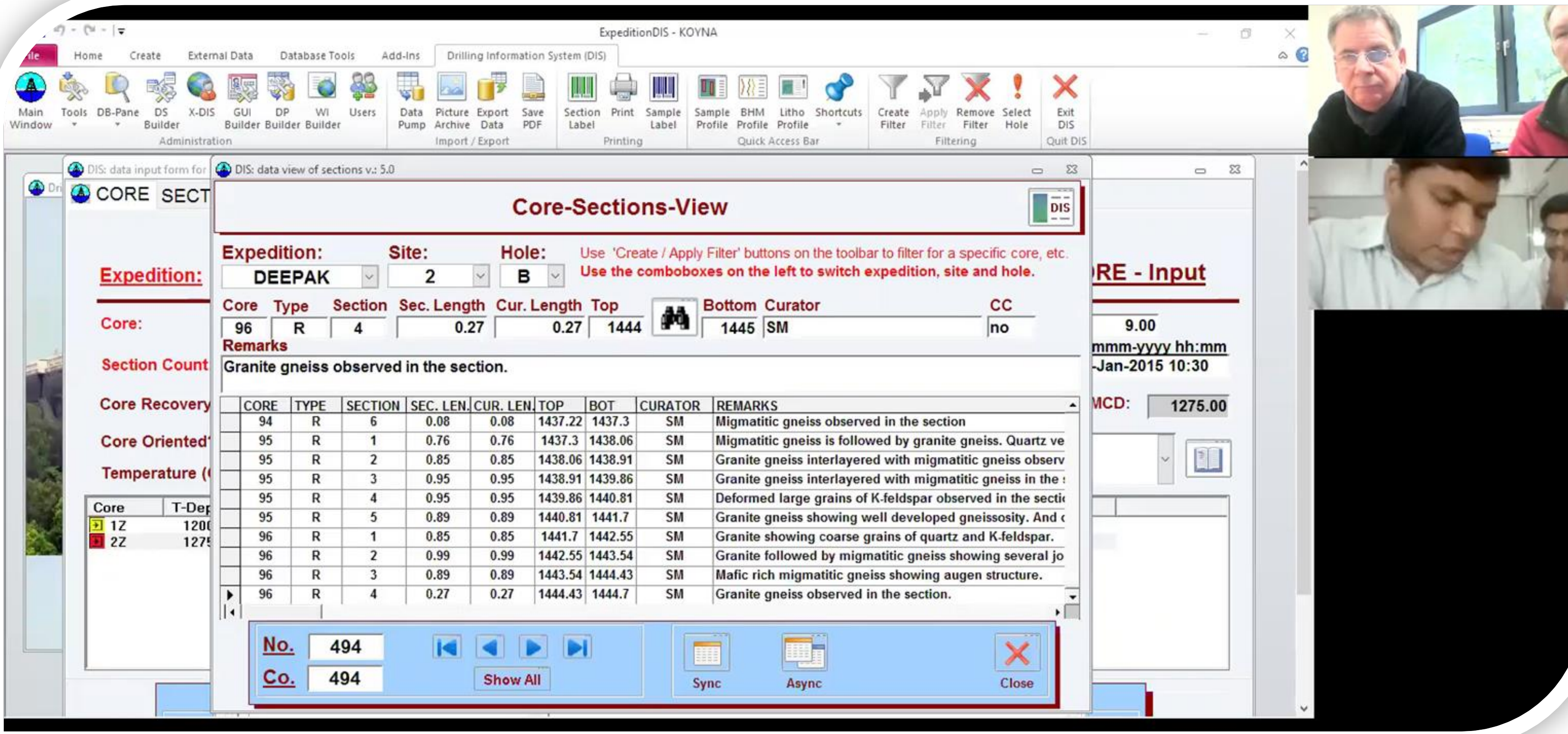
10: More on ExpeditionDIS from a current ICDP project



Team Koyna: „Share-Screen Trouble Shooting“ (same video conference)

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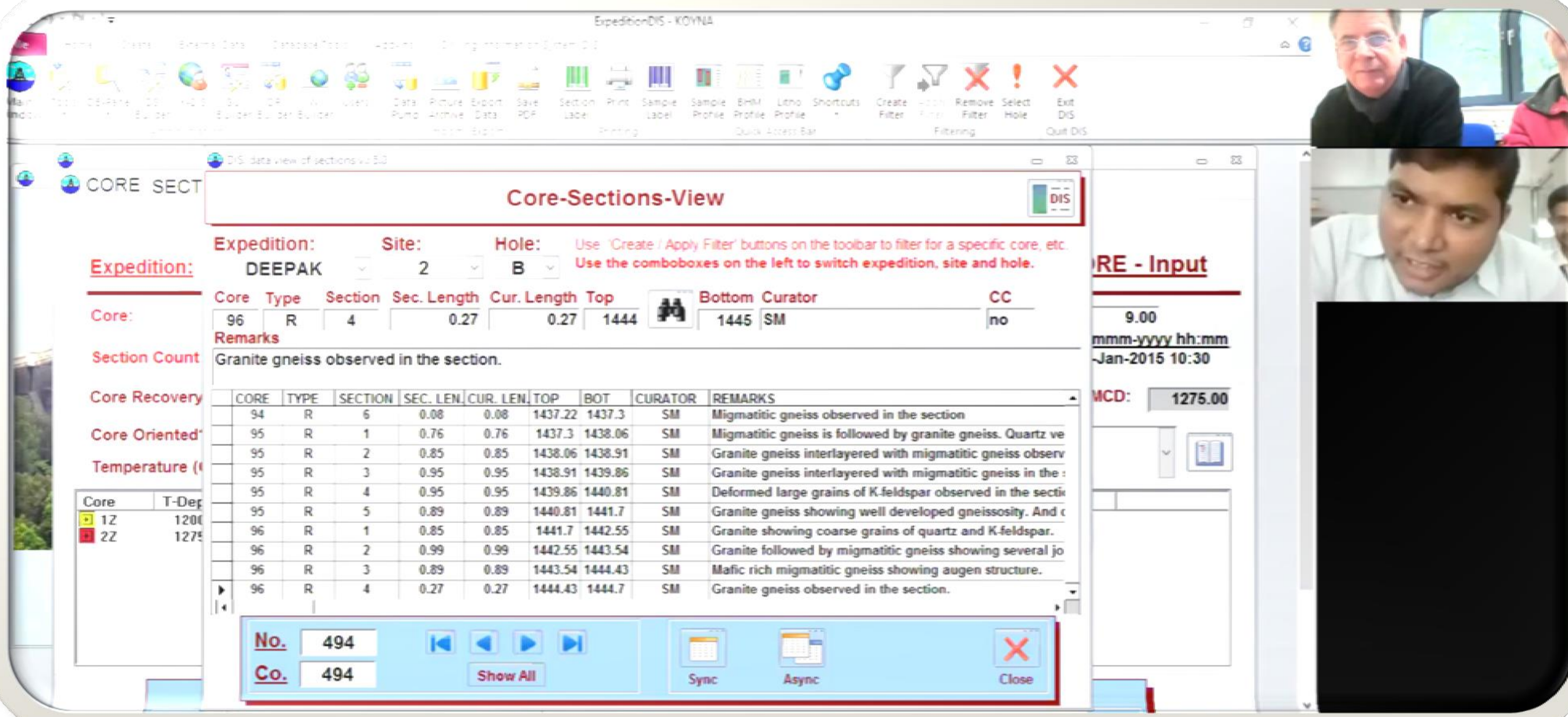
9c: More on ExpeditionDIS from a current ICDP project



Team Koyna: „Fairwell“ (same video conference)


commons.wikimedia.org
Caffè Artigiano
Let`s continue in 15 minutes ☺