Drilling / Core Processing

Anders Noren
LacCore / CSDCO, University of Minnesota

Core Processing

FIELD

- Minimal subsampling
- Prepare cores for shipment
- Metadata capture
- Drilling feedback
- Fast multisensor logging?
- Stratigraphic correlation?

LAB

- Full team regroups, intensive work
- Full suite of analytical procedures
- Nondestructive analyses first
- All cores:
  scanning, description, sampling
- Permanent curation

• • • *Both phases demand commitment* • • •

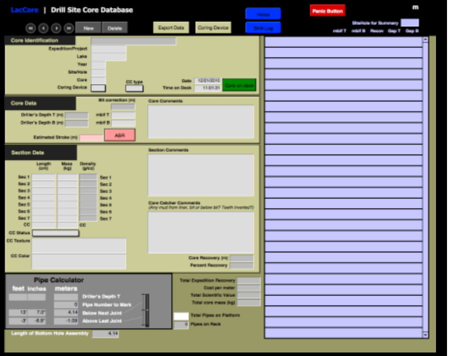
Drilling

- Successive 3m cores: 2-3 sections
- 20m / day (70? 100?)

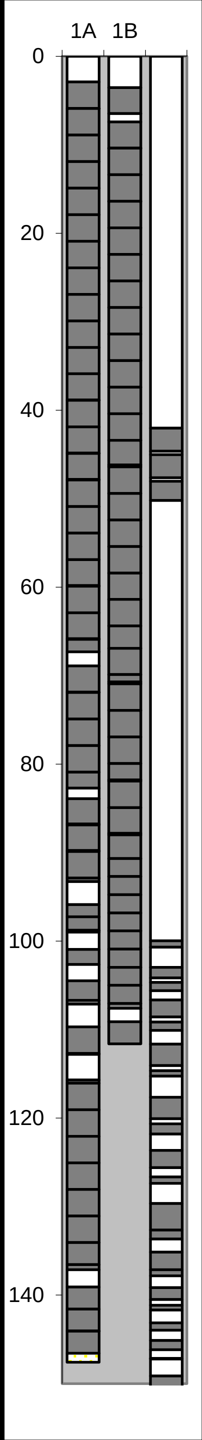
Two 12-hour shifts
Shift changes at drill site

Field Core Handling

- Package / secure
- Orient
- Identify
- Subsample
- Data capture
- Drilling engineering



Goals:
Cores identified, oriented, and associated with loc/depth
Core quality must not suffer in transit
Provide coarse-res samples to science team immediately
Optimize drilling progress



Core Handling

- Package / secure
    - drillers provide long (3m), open, core tube
    - cut sections to < 150cm
    - remove empty liner / close gaps
    - cap and seal with tape
    - bit/shoe sections into liner

- Mid-core cut(s)
  - –Section L <150cm
  - –Gas expansion?
- Scrap liner if nec
  - –Treat as a section

Lithified Core: Hammer and chisel

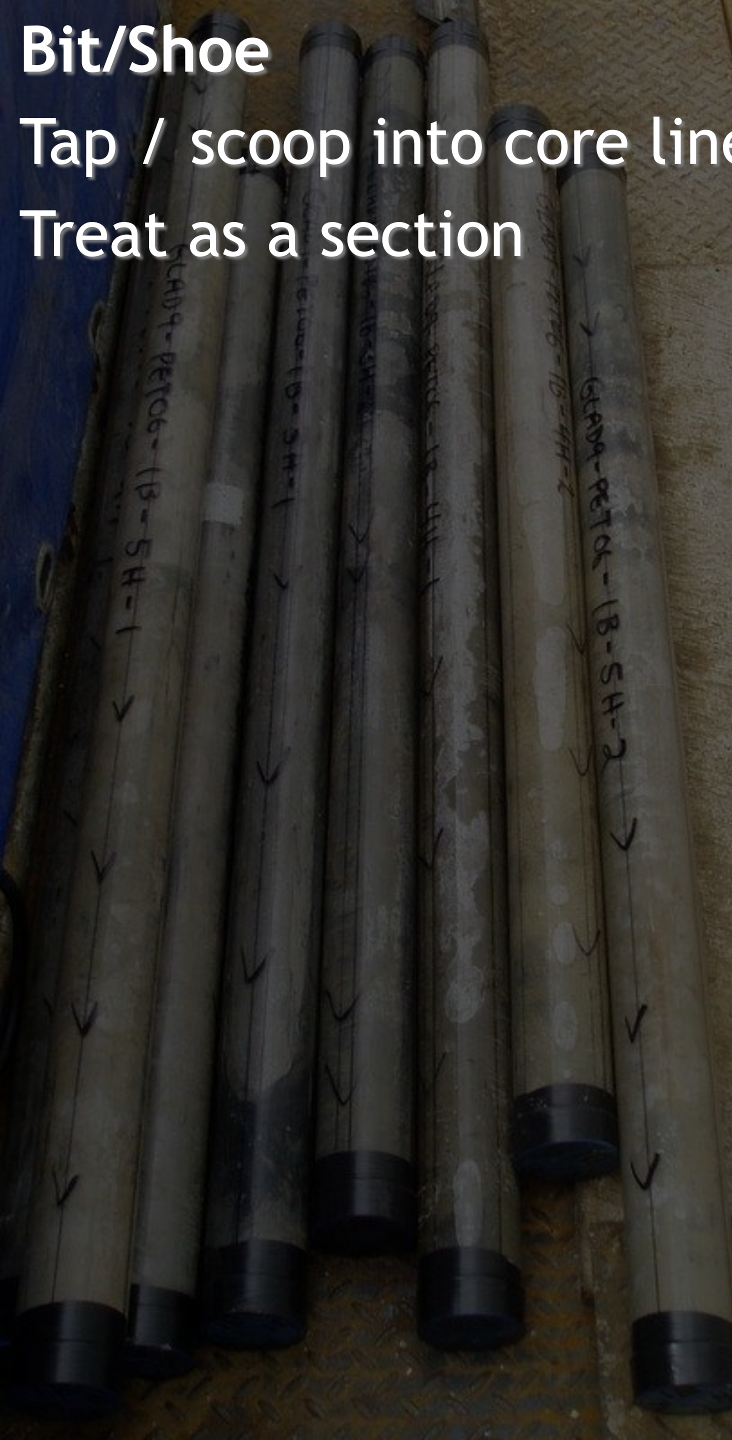
Lithified Core

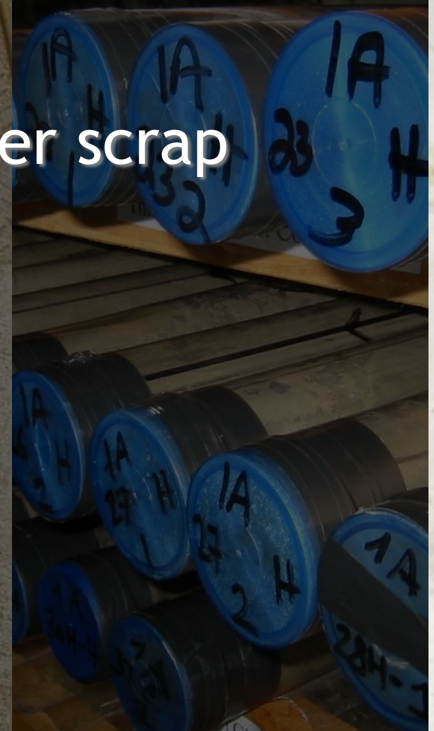

Lithified Core
Prevent re-hydration of expanding clays
Drain fluids

Bit/Shoe

Tap / scoop into core liner scrap

Treat as a section





Core Handling

- Orient
  - UP arrows
  - T and B labels
  - Color-coded endcaps (blue = up)

Core Handling

- Identify

Project - LocationYear - SiteHole - CoreTool - Section

GLAD9-PET06-1A-1H-1
5033_1_A_1_H_1

Project _ Site _ Hole _ Core _ Tool _ Section

Core Handling

- Identify

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Project _ Site _ Hole _ Core _ Tool _ Section

Core Handling

- Identify
  - Handwritten (labels scratch/peel)
  - Minimal label on cap

Lithologic Description

- requires drilling without liner
- liners obscure lithology

Liners are critical

Core Handling

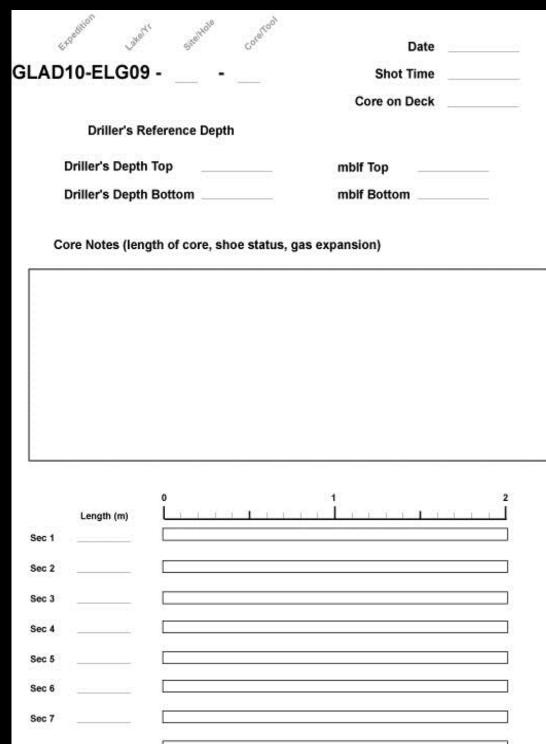
- Sampling
  - bit / shoe / corecatcher, section cuts
    - color
    - texture
    - smear slides
    - pore waters
    - small subsamples for rapid analysis post-drilling
  - other locations for analyses requiring immediate sampling (e.g. biogeochem)
  - drilling fluid additives
  - capture sampling information in spreadsheets
  - upload to database later

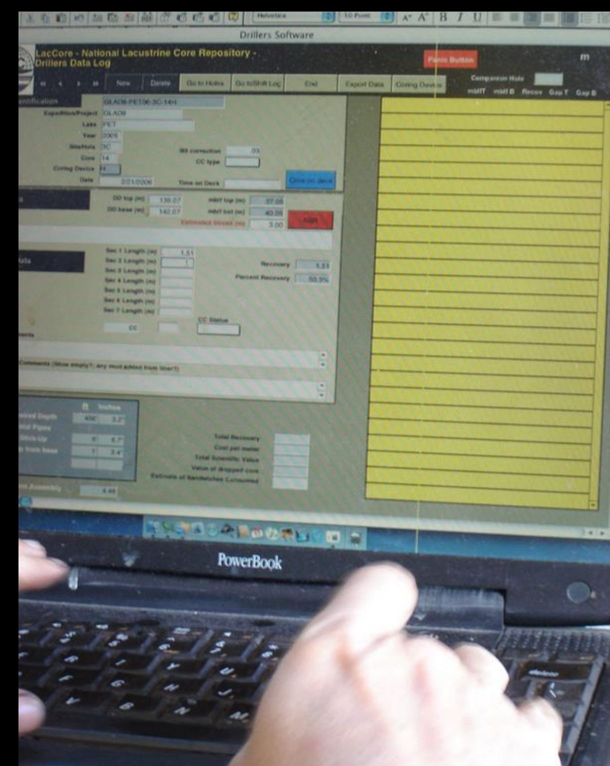
Core Handling

- Metadata capture
  - section lengths
  - depth interval drilled (mbs)
  - date + time
  - drilling notes
  - basic lithology
  - drilling fluid additives
  - core weights
  - samples
  - personnel

Core Handling

- Metadata capture
  - paper copy
  - LacCore Drill Site Database
  - standard formats





Common Driller Errors

- meter/feet conversions

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- drill pipe in 10-foot lengths / cores are 3m length (Δ 4.8cm)

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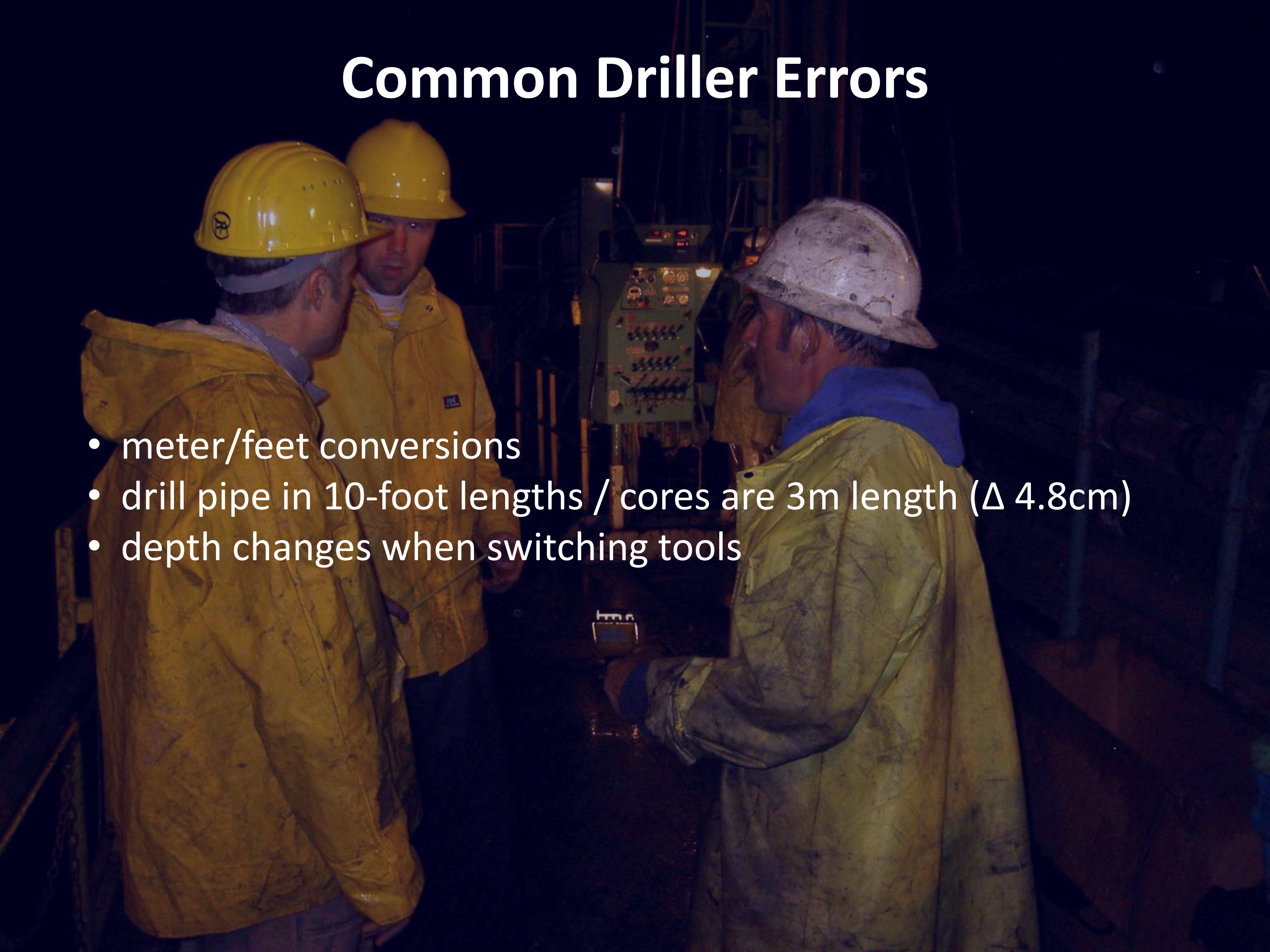

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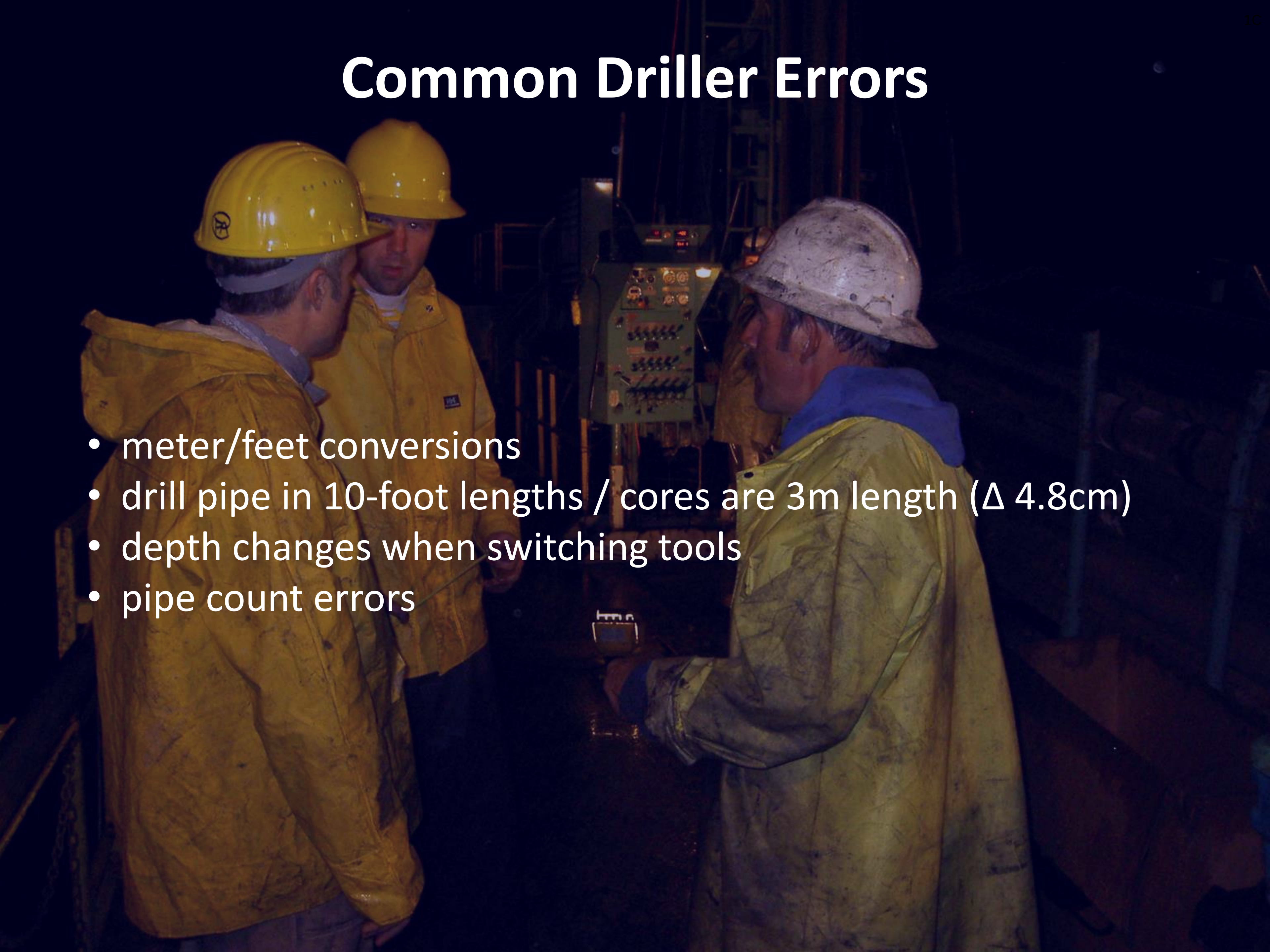

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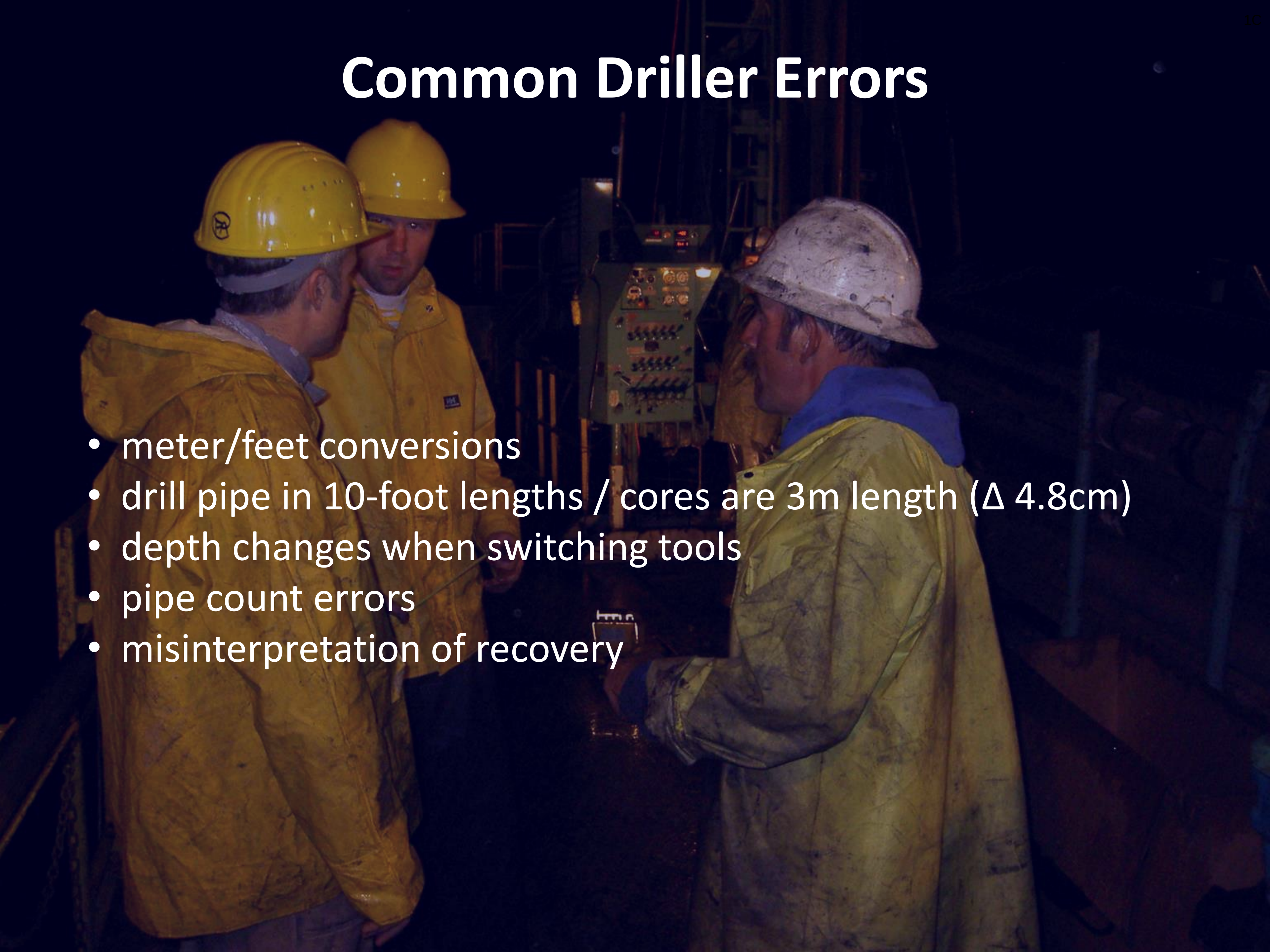

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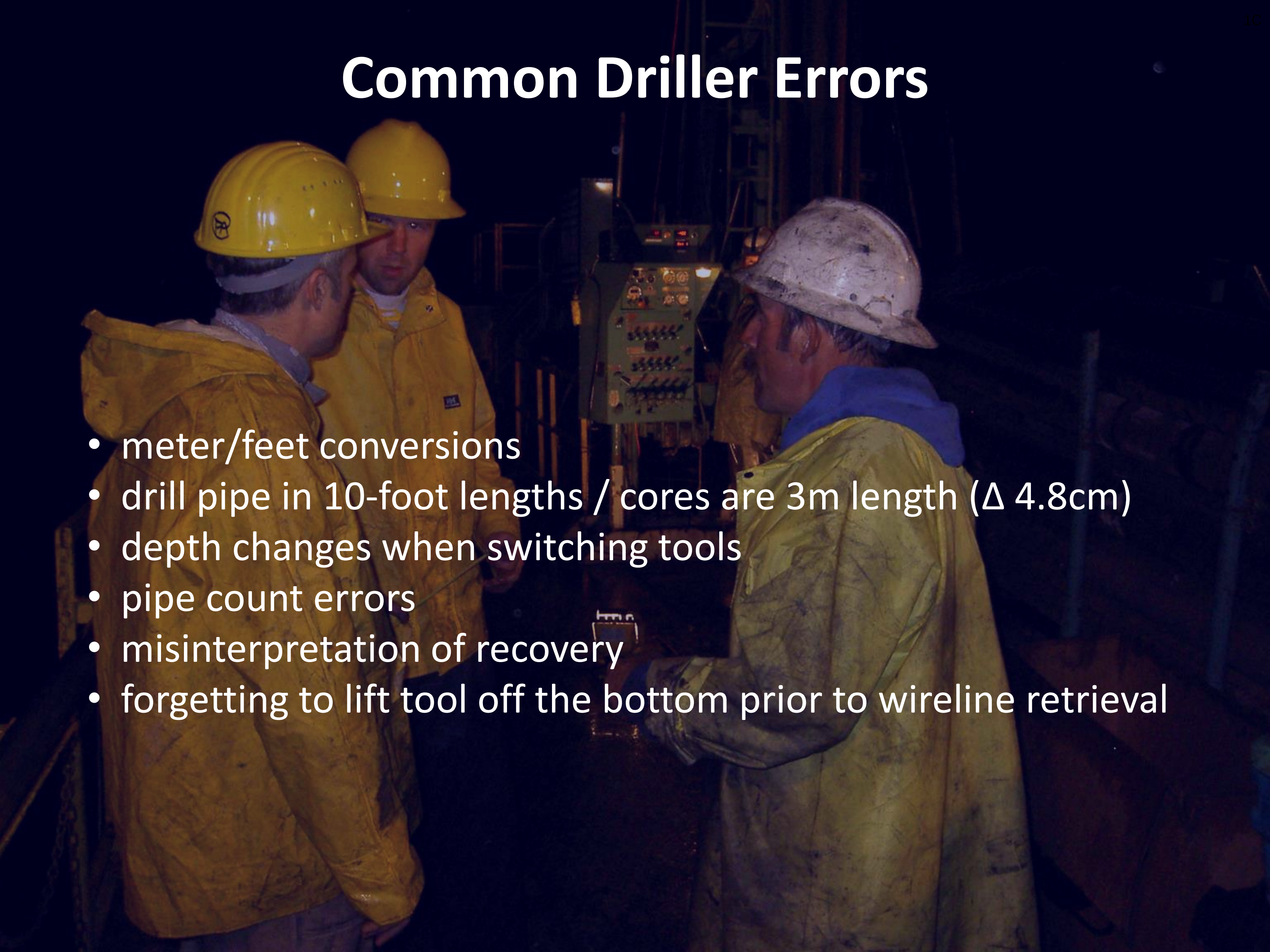

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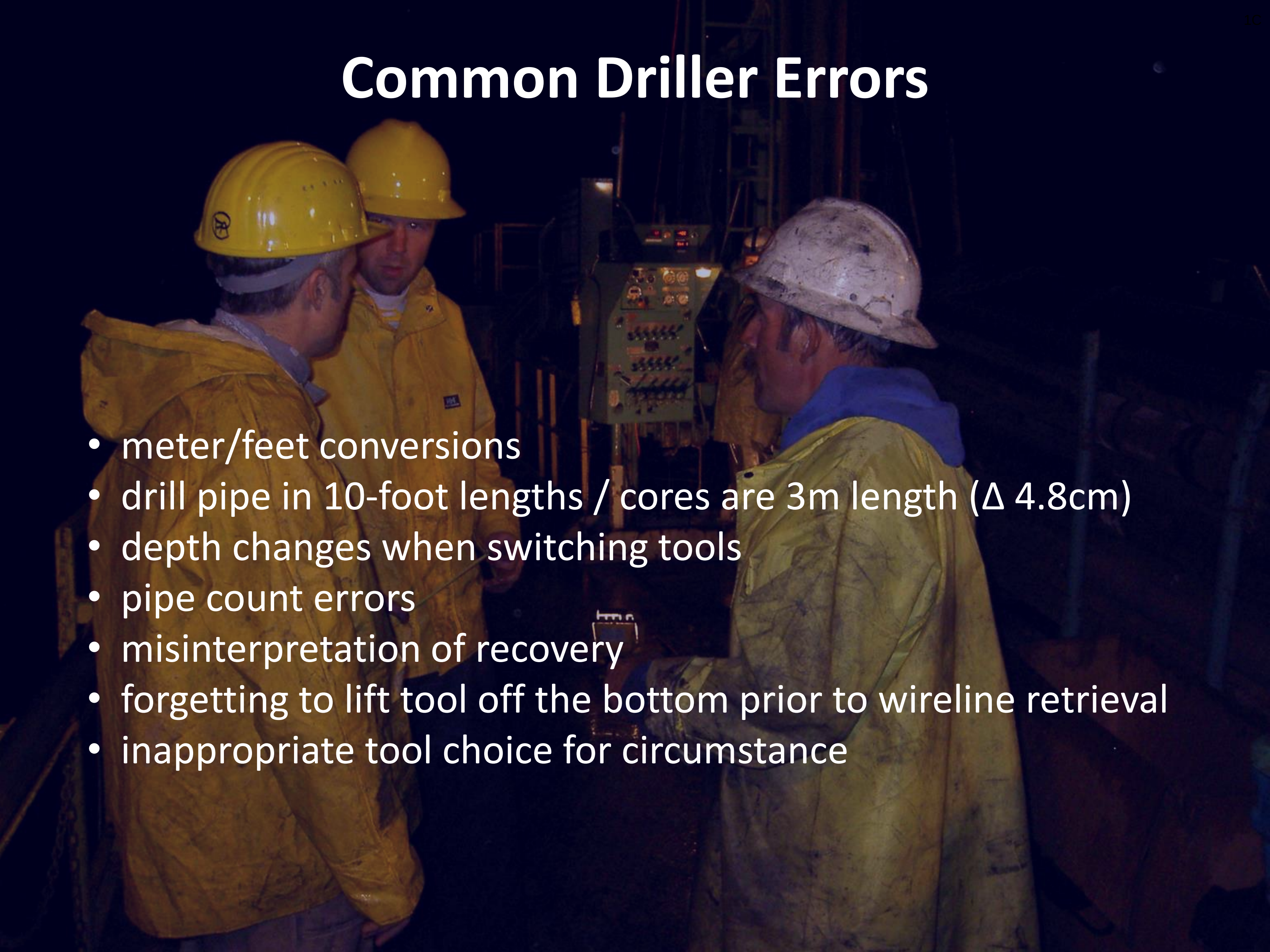

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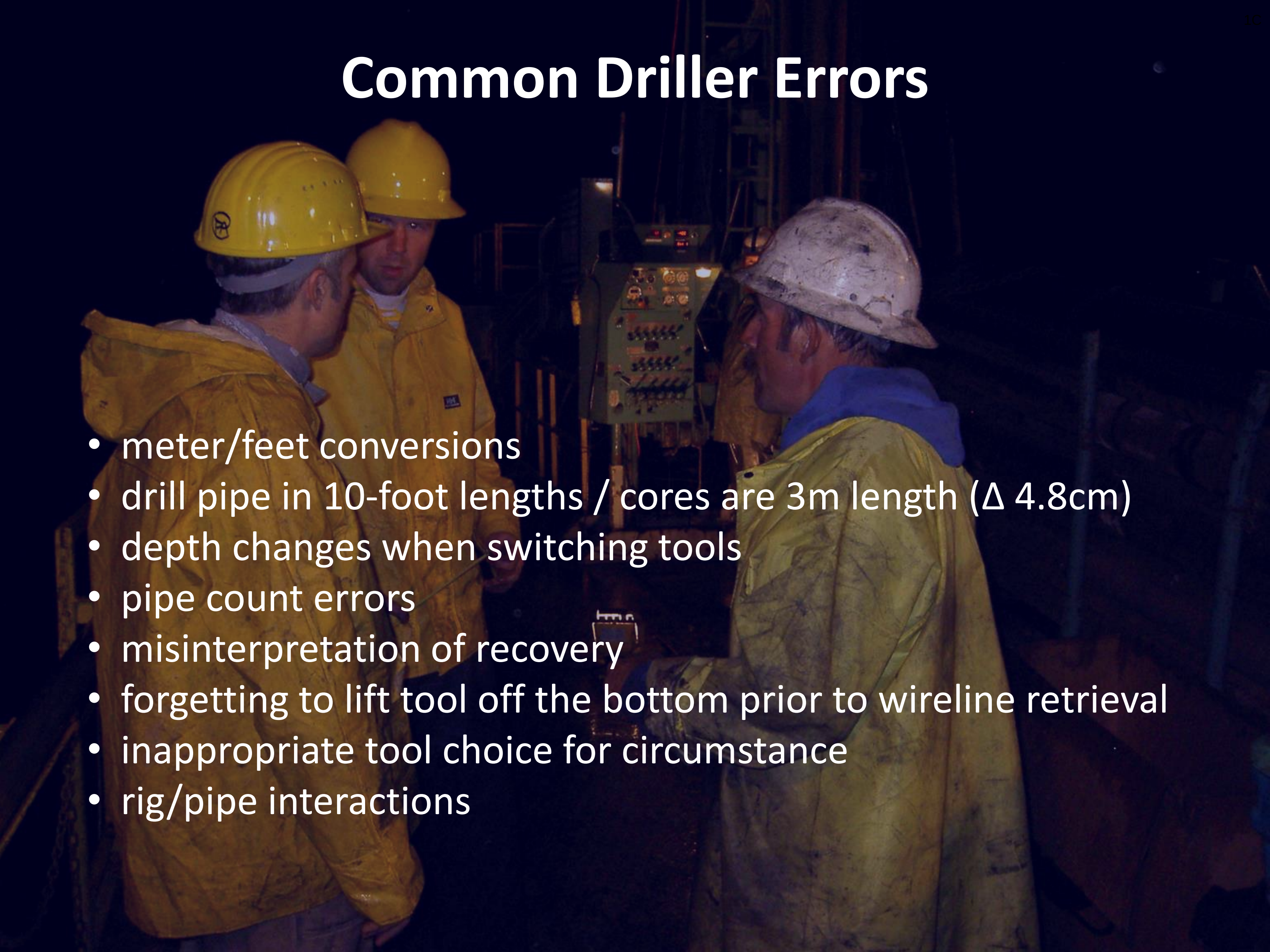

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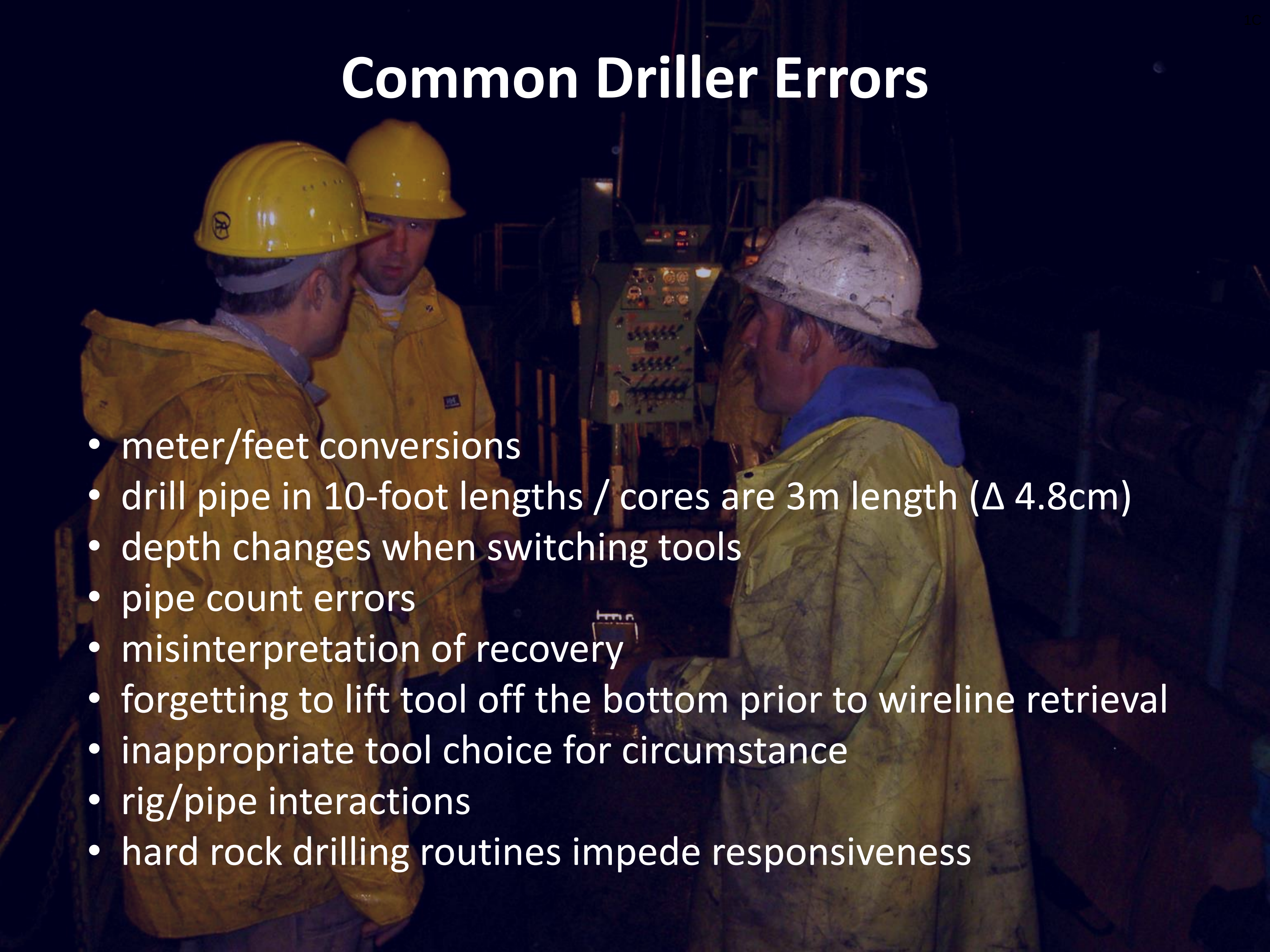

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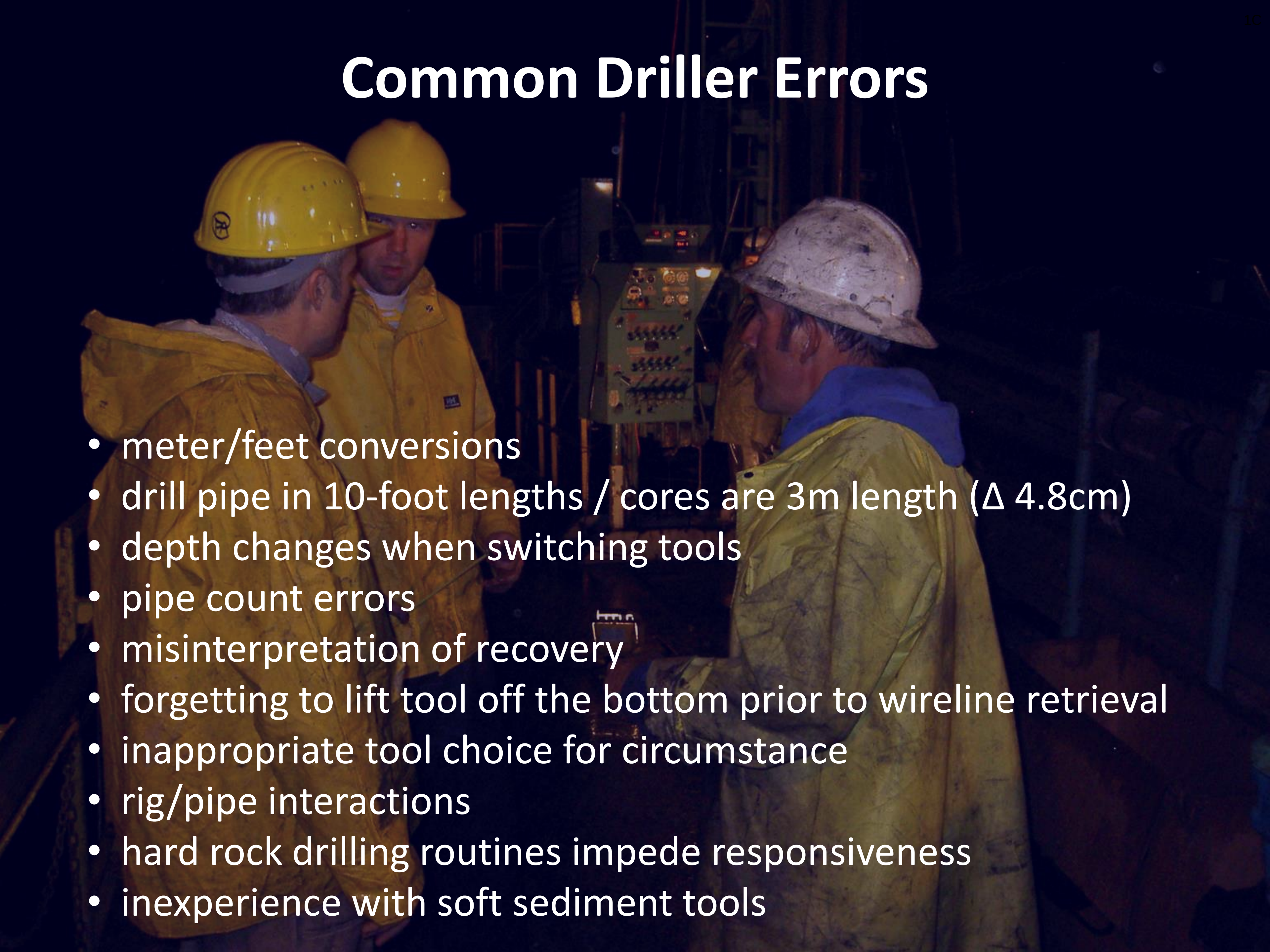
- rig/pipe interactions
- hard rock drilling routines impede responsiveness

Common Driller Errors



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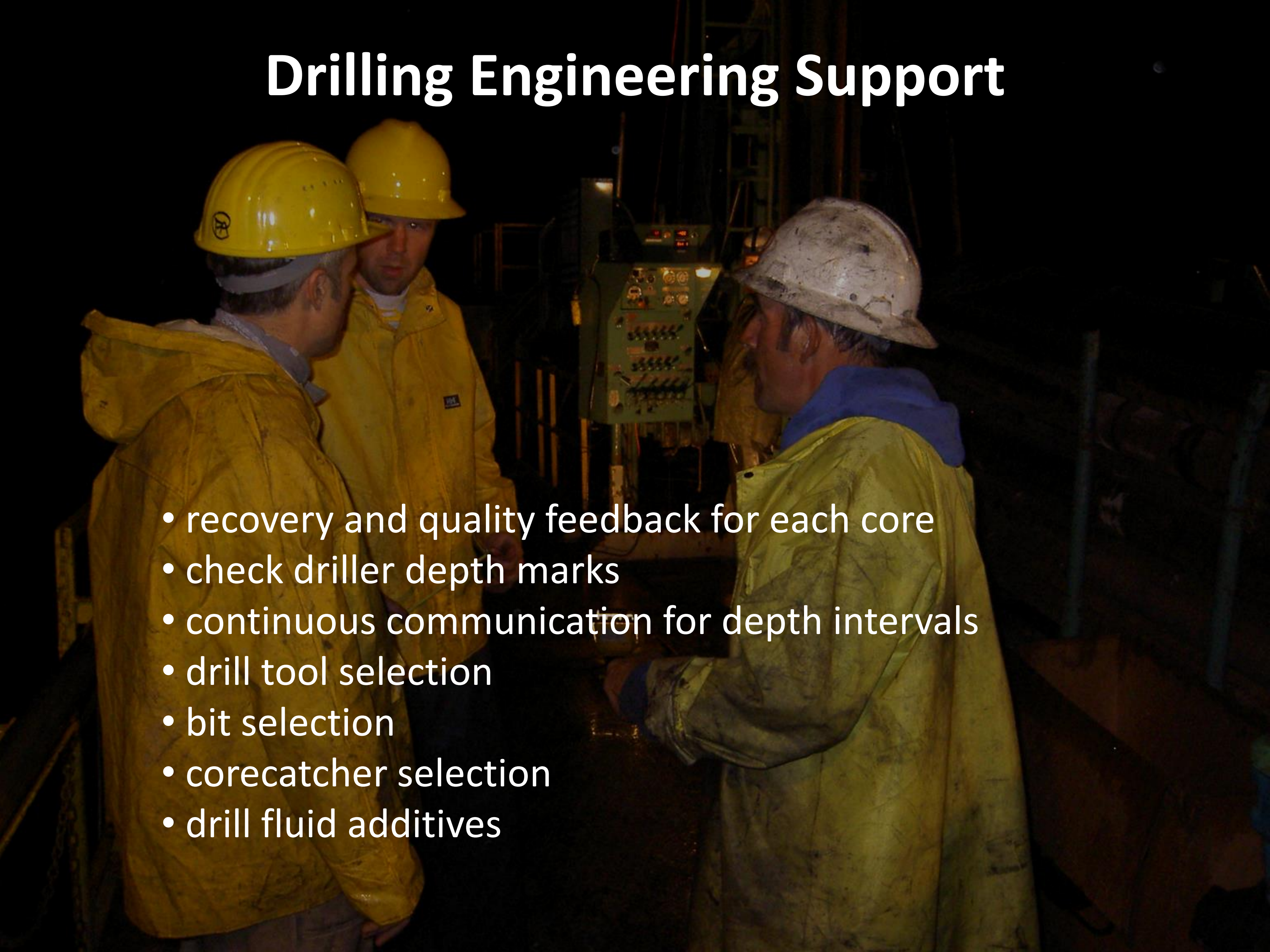
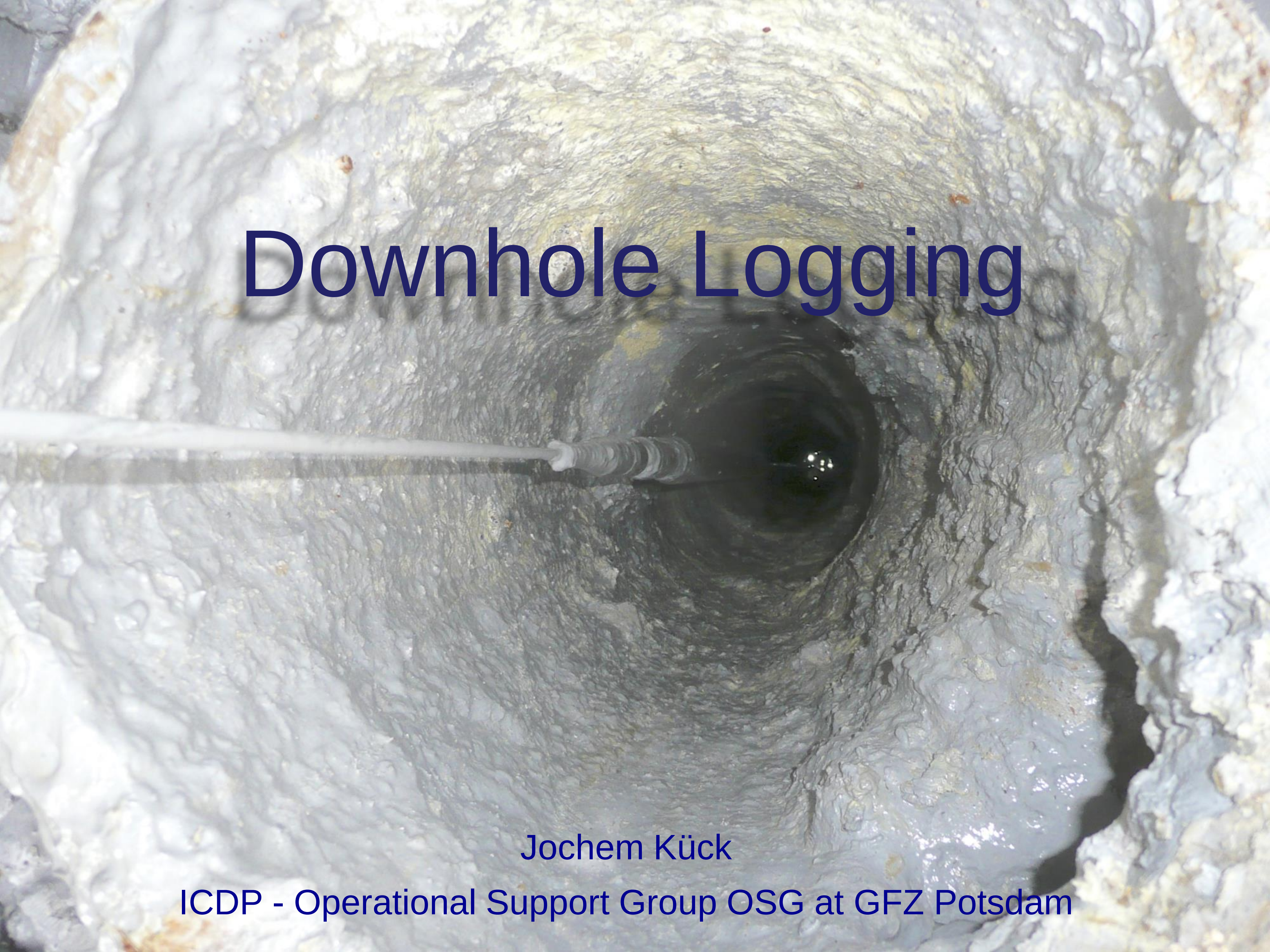
- misinterpretation of recovery
- forgetting to lift tool off the bottom prior to wireline retrieval
- inappropriate tool choice for circumstance
- rig/pipe interactions
- hard rock drilling routines impede responsiveness
- inexperience with soft sediment tools


Drilling Engineering Support
• recovery and quality feedback for each core
• check driller depth marks
• continuous communication for depth intervals
• drill tool selection
• bit selection
• corecatcher selection
• drill fluid additives



Downhole Logging

Jochem Kück

ICDP - Operational Support Group OSG at GFZ Potsdam

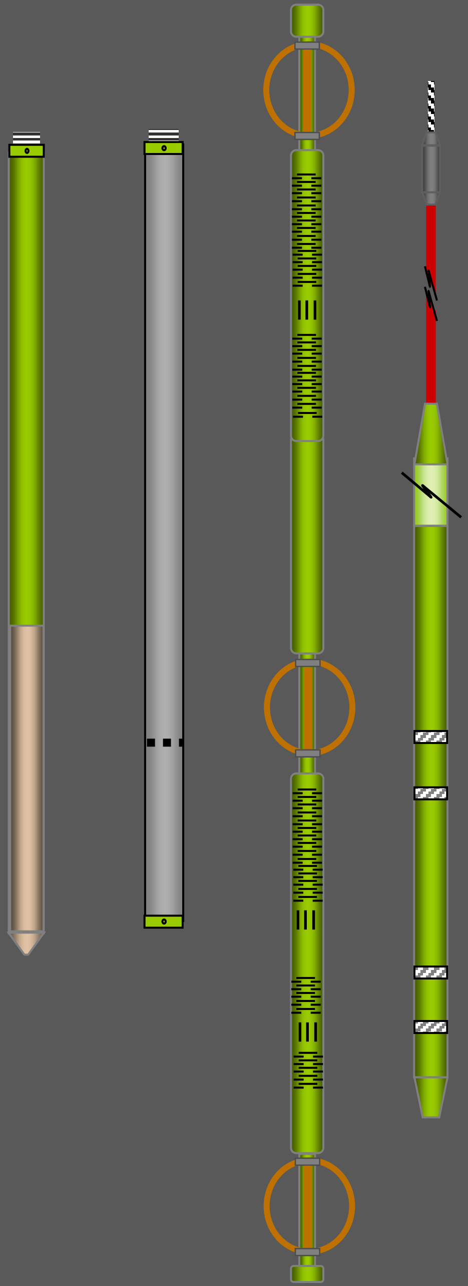
OSG Slimhole Tools

MS - Magnetic Susceptibility
magnetic susceptibility

SGR - Spectrum Gamma Ray
natural total GR; K, U & Th content

BS - Borehole Sonic
sonic velocity, full waveforms

DLL - Dual Laterolog
resistivity: deep & shallow



OSG Slimhole Tools

DIP - Dipmeter

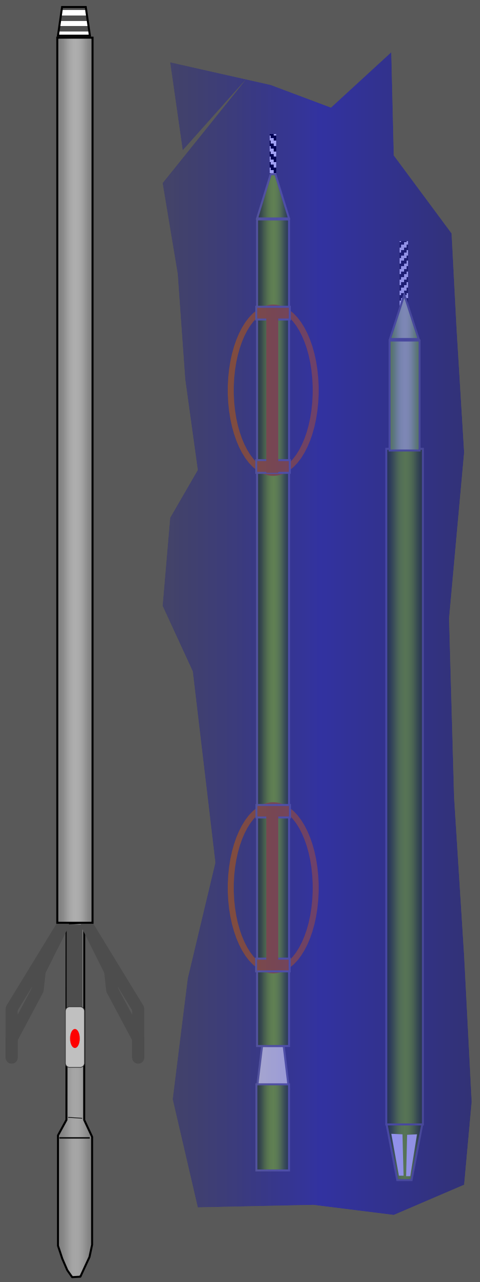
hole azimuth, deviation, caliper, structural dip, total magnetic field

FAC40 - Borehole Televiewer

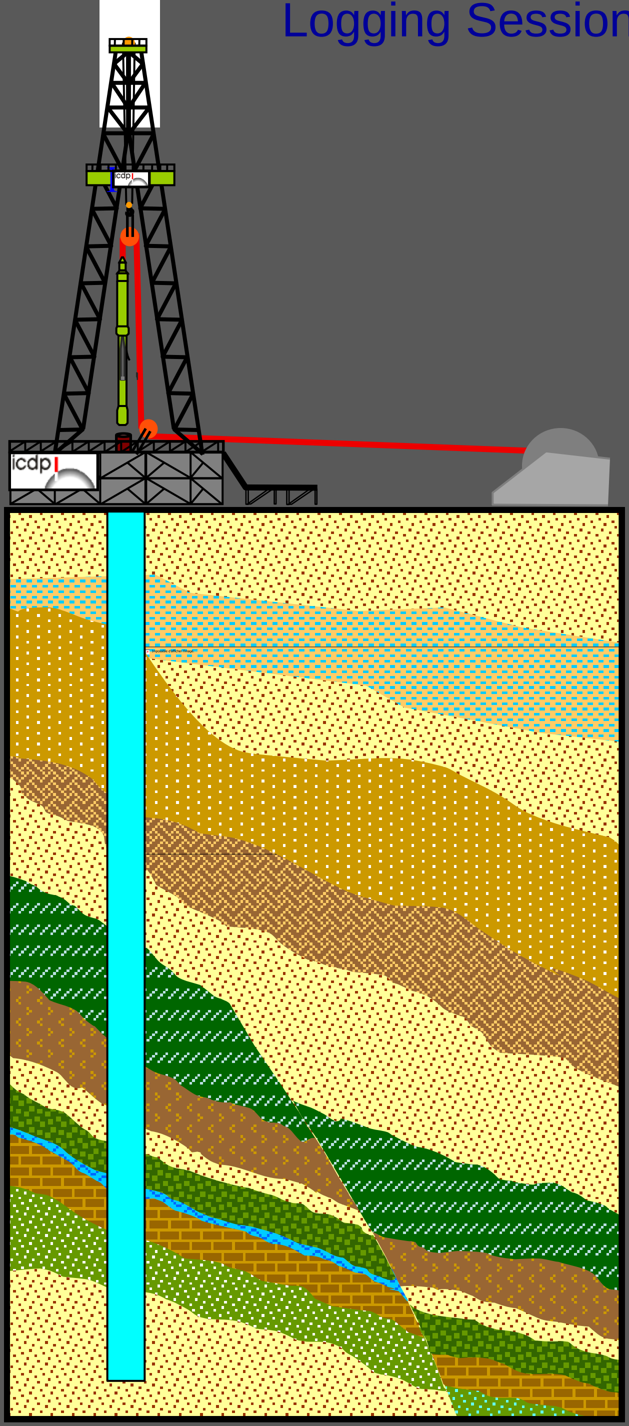
acoustical borehole wall images, hi-resolution caliper

MP - Mud Parameters

mud pressure, temperature & resistivity

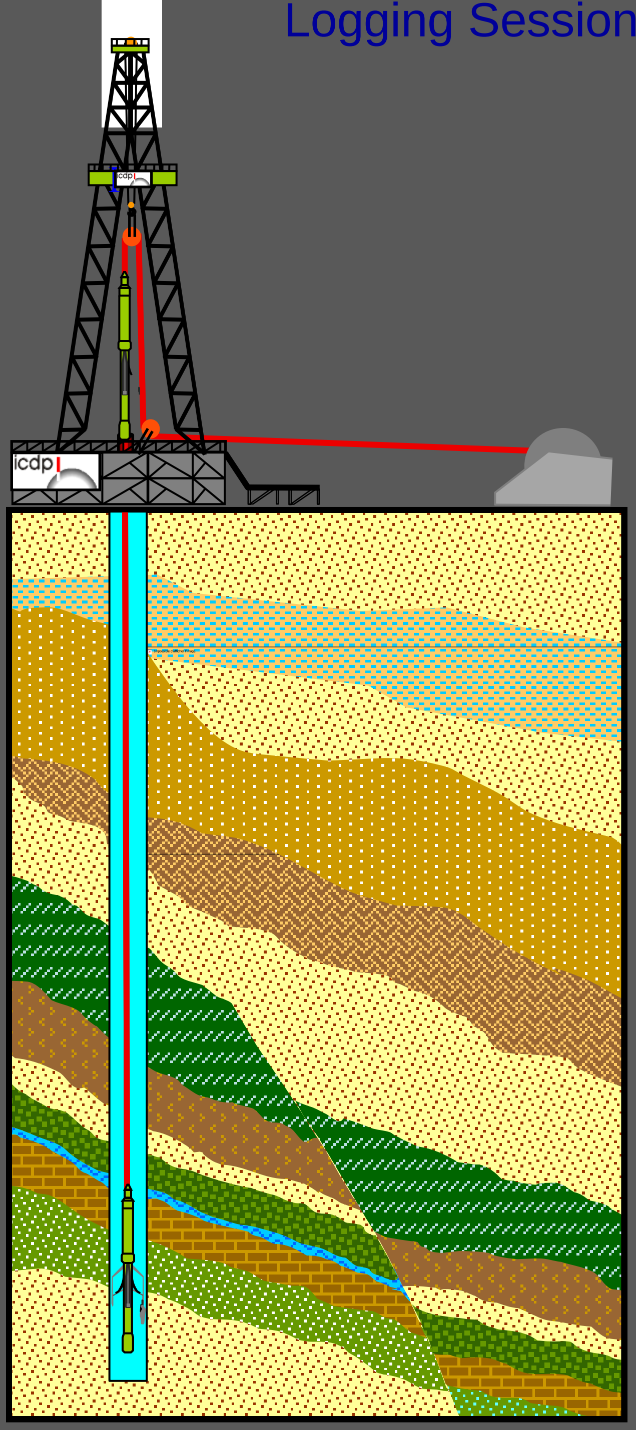


Logging Session



Sonde #1

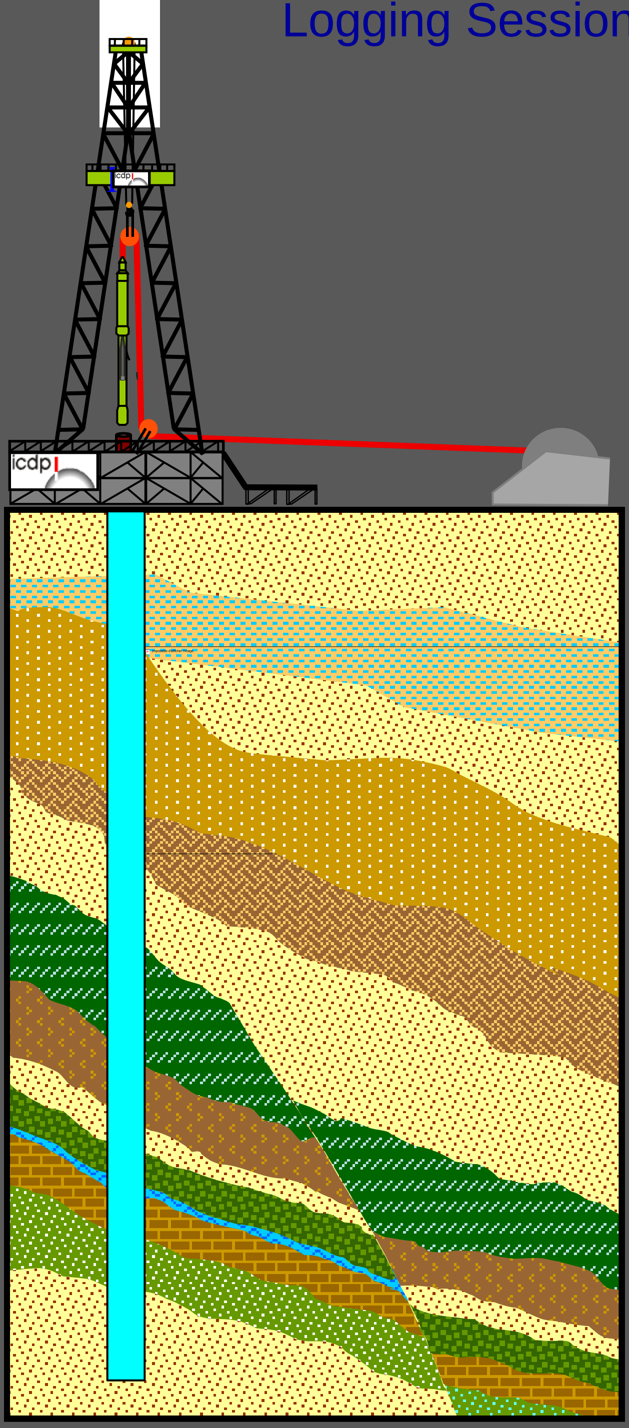
Logging Session



Sonde #1

Logging upward

Logging Session



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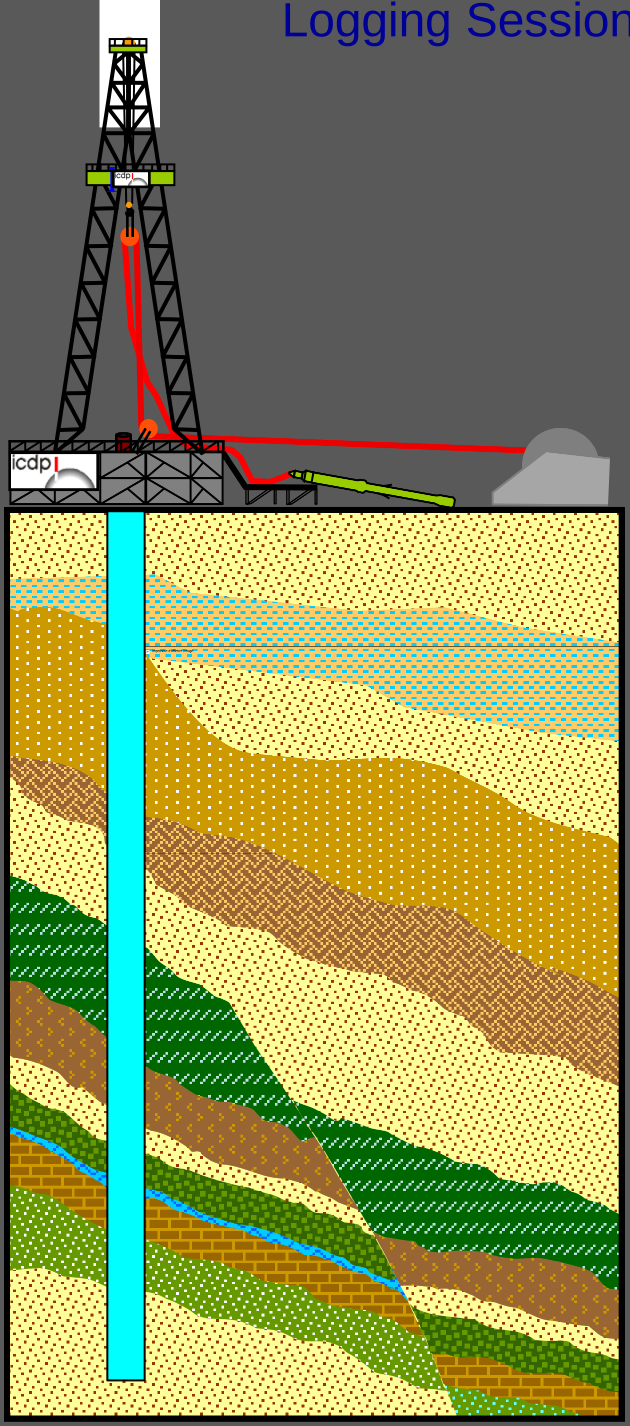
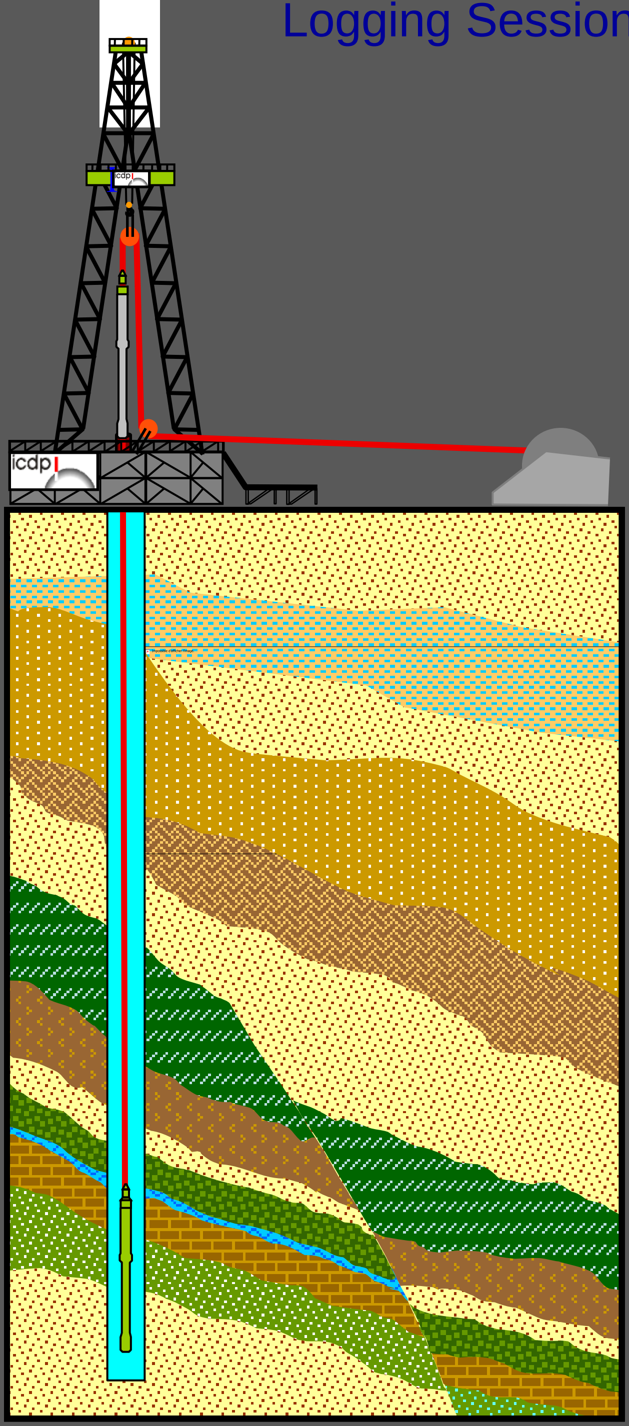
Logging Session



Sonde #2

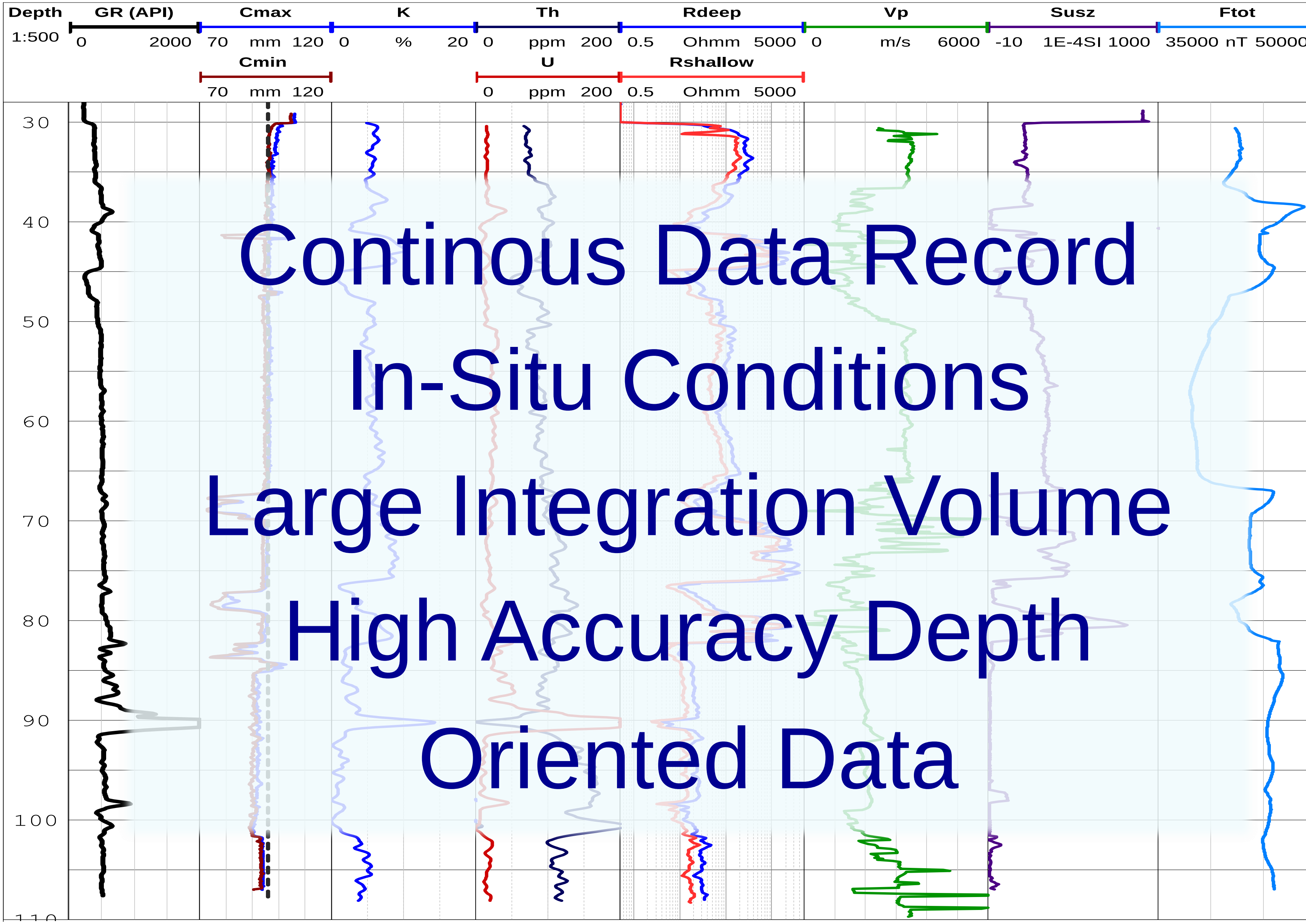
Logging Session



Sonde #2

Logging upward

Why downhole logs?



Continous Data Record

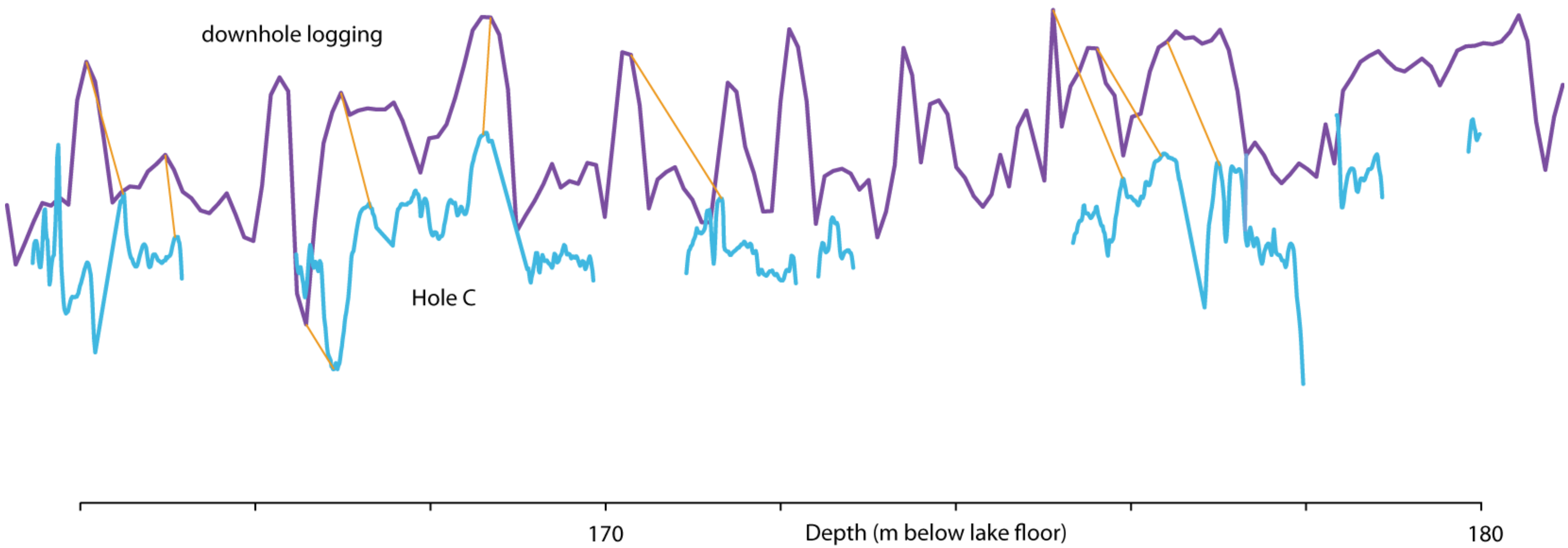
In-Situ Conditions

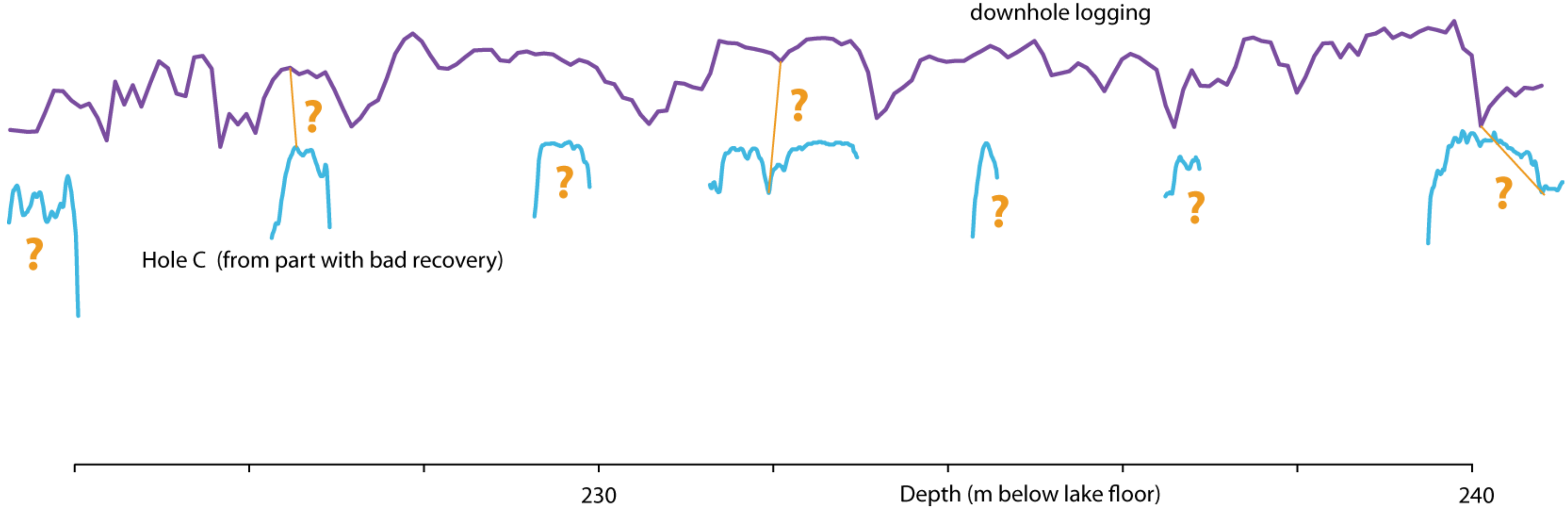
Large Integration Volume

High Accuracy Depth

Oriented Data

Match between MS and down hole logging MS





On-site Science

On-site Science: Multisensor Logs

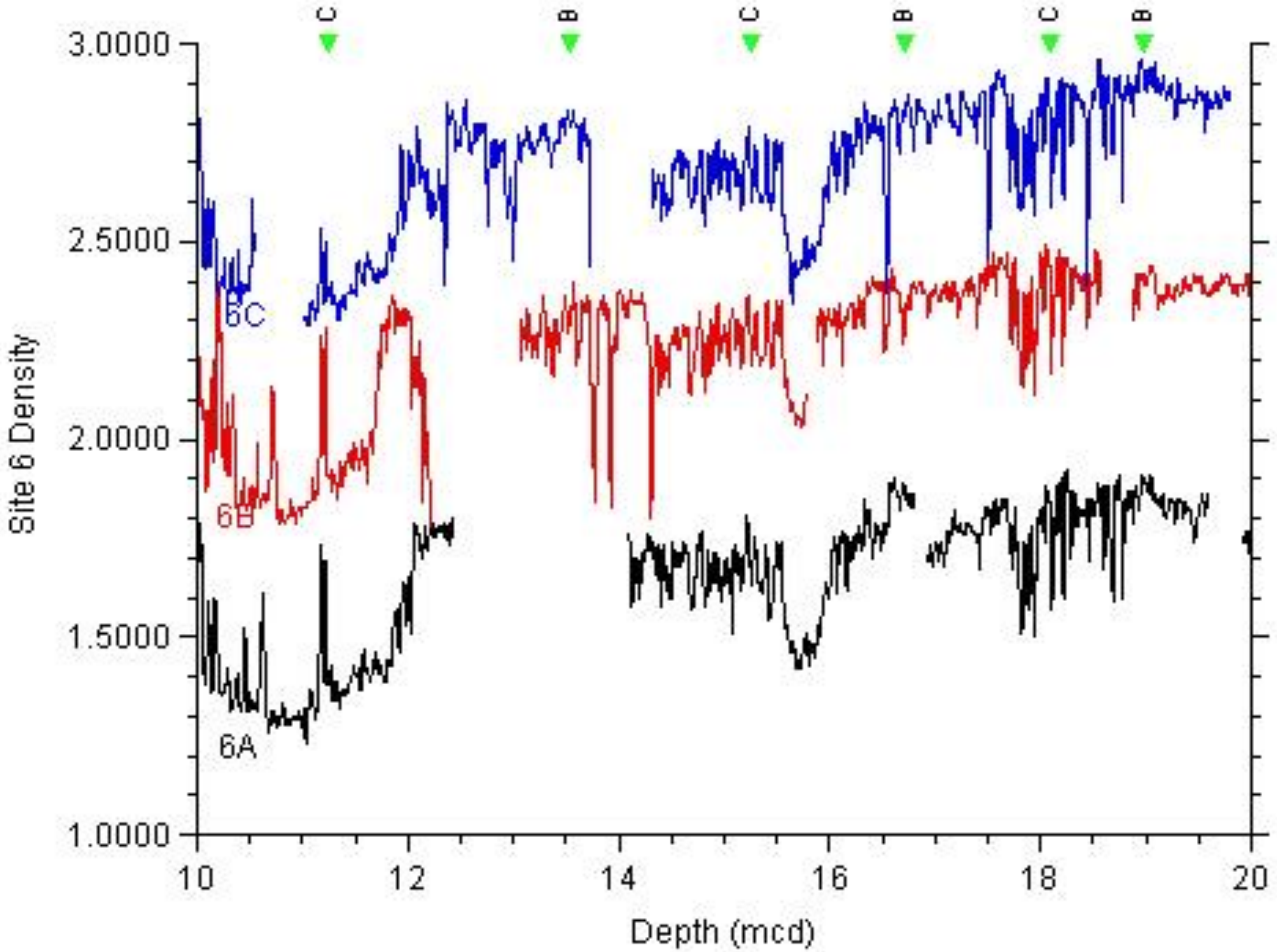
Magnetic susceptibility

- Fast, low-res, low-sensitivity
- Keep pace with drilling

Repeat logging in lab: high-res, high sensitivity

On-site Science: Stratigraphic correlation

Correlator



Shore Science: Subsamples

Shore Science: Stratigraphy

Core Storage / Freight

On-site

- Reefer container
- Walk-in refrigerator
- Room with A/C
- Garage / shed / tent
- Shaded area

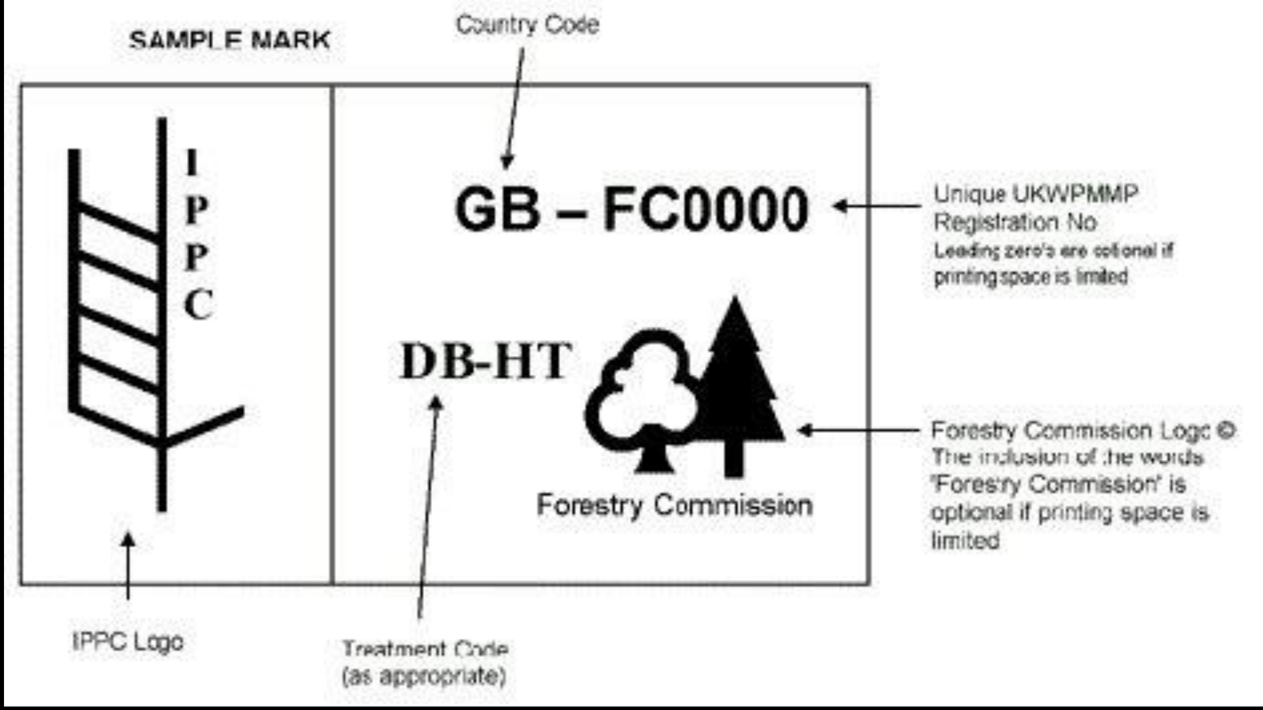
Freight

- Airfreight
- Reefer container
- Dry container

ISPM-15 certification

ISPM 15 Certification

- **Heat Treatment**
- **Fumigation**



2.1 Exemptions

The following articles are of sufficiently low risk to be exempted from the provisions of this standard:

- wood packaging made wholly of processed wood material, such as plywood, particle board, oriented strand board or veneer that has been created using glue, heat or pressure

Logistics

Housing and Personnel

1. Housing for 15+
   a. 8 drillers
      i. Drillers (2)
      ii. Helpers (4)
      iii. Supervisor (2)
   b. 8 drill site scientists
      i. Curators/Company Rep (2)
      ii. Core handlers (4)
      iii. Downhole loggers (2)
   c. 1 lab scientist
      i. MSCL / DB / core mgmt, smear slides, strat correlator (1)
      ii. Manager ?

Logistics

Fuel / Power

1. Drill rig: ~400-600L diesel / day (depending on rig)
2. Core reefer container
    1. 220V, 60A (15kW) hardwired, or
    2. 75-100L diesel / day
3. Vehicles (2-3): gasoline, diesel

Logistics

Housing and Personnel (cont.)

1. Meals: Breakfasts / dinners: 6a/8a, 6p/8p ?   Lunches at drill site
2. Comms: mobile/satellite phones, radios (drill site, camp/hotel/lab)
3. Internet: USB modems, Inmarsat BGAN
4. Laundry: service
5. Waste disposal: garbage from drill site, toilet pit

Supplies

- Drilling contractor provides tubes and caps
- Tape, markers, pens, pencils, rags, brushes, buckets, core crates
- Sampling tools, sample containers, sampling supplies
- Hand tools: drills, drill bits, utility knives, pipe cutters, hack saws, chisels, hammers, cutting cylinders, screwdrivers, measuring tapes
- Core data sheets, clipboards, laptop
- Scale, temperature data logger
- Mobile / cell phones

Outreach

Outreach

Public / Local

- Neighbors: Individual meetings
- Community meetings
- Schools
- Museums

Public / Local to Global

- Newspapers
- TV stations: access, or footage. Documentary?
- Radio

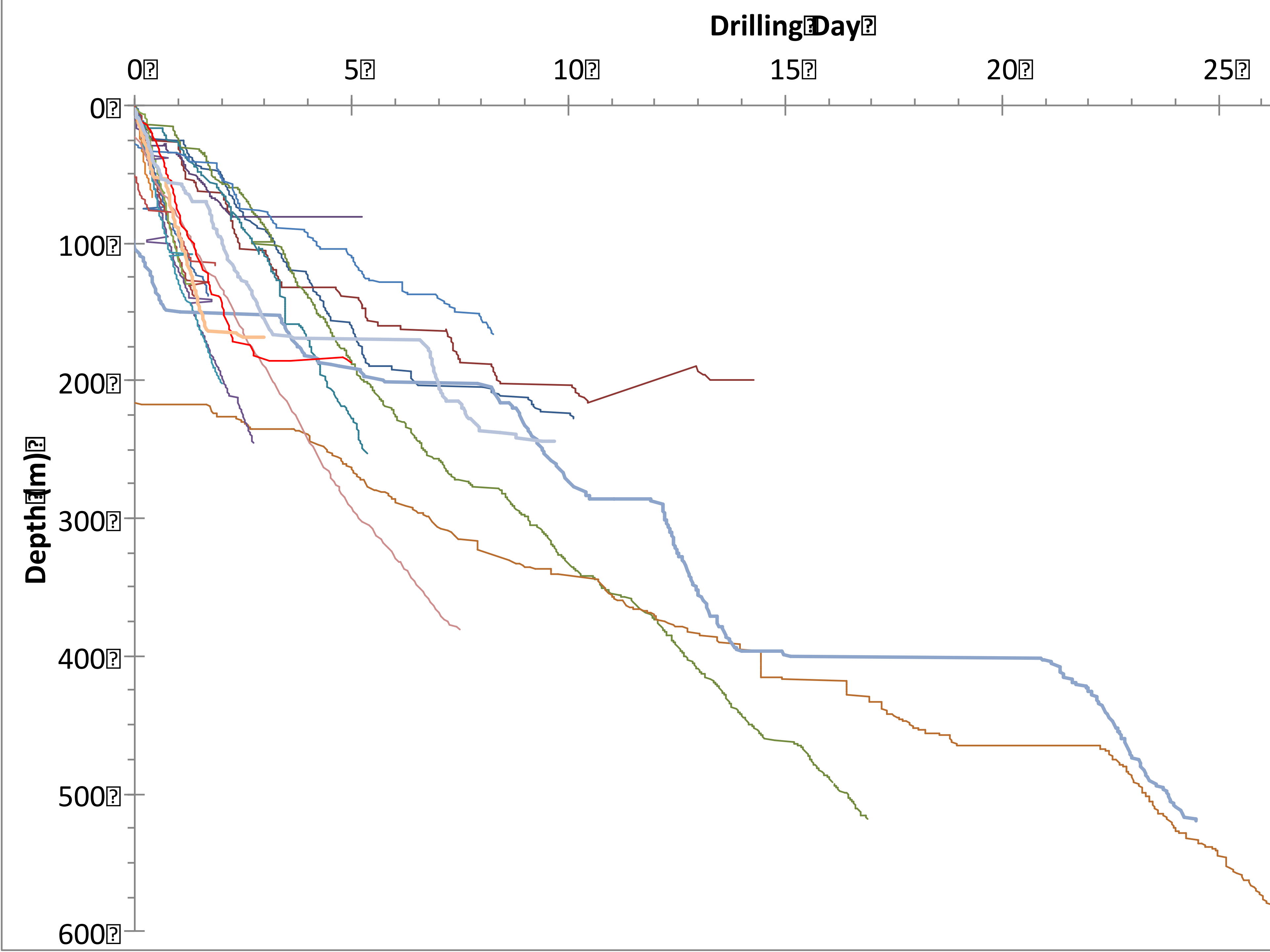
Scientific Community

- Facebook page
- Twitter hashtags #HSPDP #ICDP
- Institutional news pages

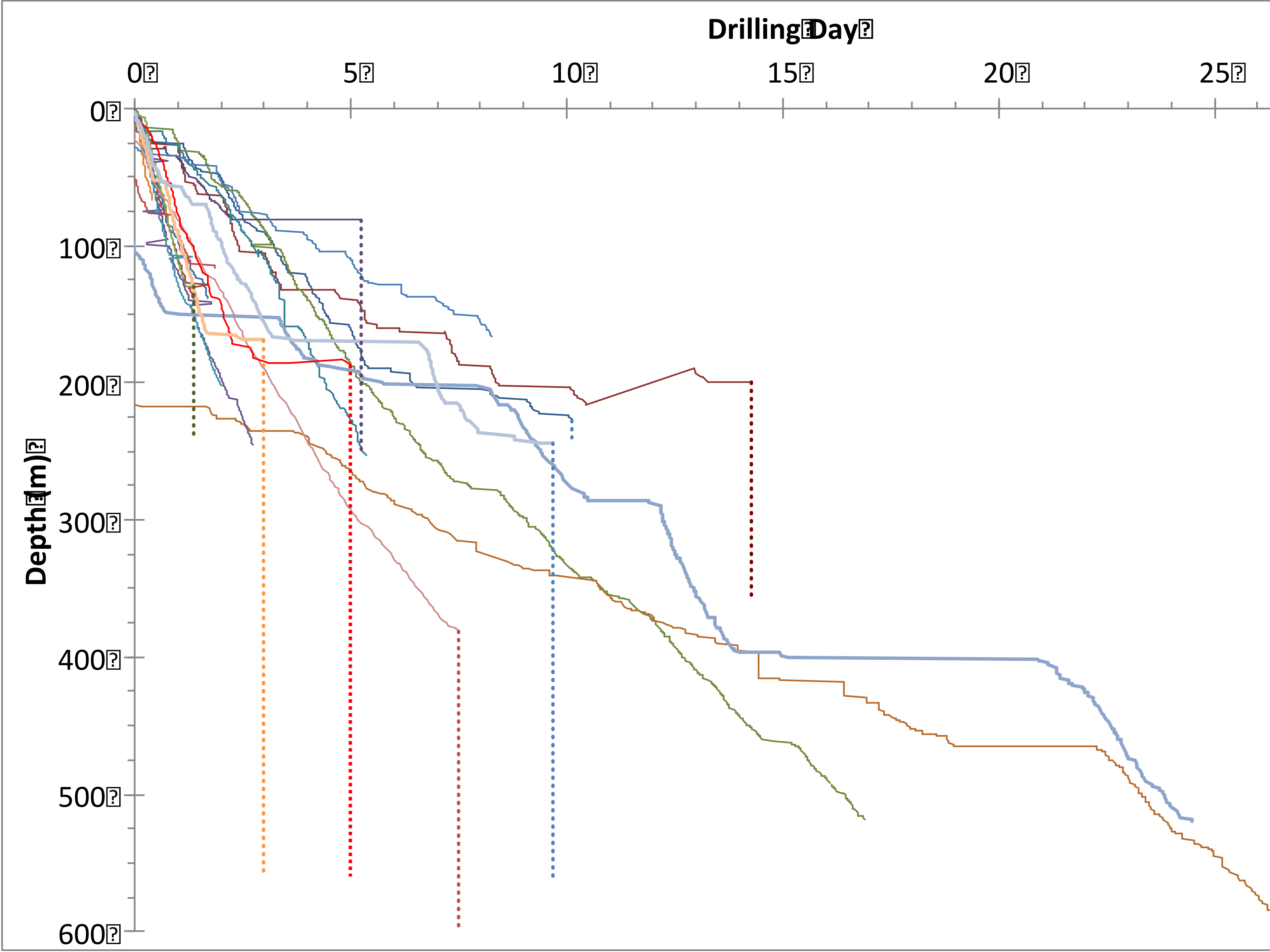
We can help design/execute!

Challenges

- **Shipping / Customs**
- **Logistics**
- **Equipment failure**
- **Communication**
- **Formation character**
- **Weather**
- **Politics**



Drilling Day
0
5
10
15
20
25
0
100
200
300
400
500
600
Depth (m)



Drilling Day
0
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10
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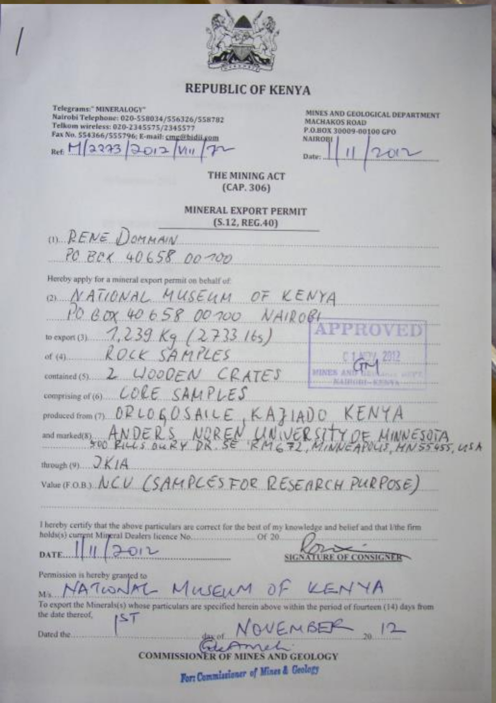
Depth (m)

Core Freight

- Export permit
- Surface vs Air



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REPUBLIC OF KENYA

Telegrams:" MINERALOGY"
Nairobi Telephone: 020-558034/556326/558782
Telkom wireless: 020-2345575/2345577
Fax No. 554366/555796; E-mail: cmg@bidii.com
Ref: M/2273/2012/VIII/72

MINES AND GEOLOGICAL DEPARTMENT
MACHAKOS ROAD
P.O.BOX 30009-00100 GPO
NAIROBI
Date: 1/11/2012

THE MINING ACT
(CAP. 306)

MINERAL EXPORT PERMIT
(S.12, REG.40)

(1) RENE DOMMAIN
PO BOX 40658 00100

Hereby apply for a mineral export permit on behalf of:

(2) NATIONAL MUSEUM OF KENYA
PO BOX 40658 00100 NAIROBI

to export (3) 1,239 Kg (2733 lbs)

of (4) ROCK SAMPLES

contained (5) 2 WOODEN CRATES

comprising of (6) CORE SAMPLES

produced from (7) ORLOGOSAILE, KAJIADO KENYA

and marked(8) ANDERS NOREN UNIVERSITY OF MINNESOTA
500 PILLSBURY DR. SE RM672, MINNEAPOLIS, MN55455, USA

through (9) JKIA

Value (F.O.B.) NCV (SAMPLES FOR RESEARCH PURPOSE)

APPROVED
01 NOV 2012
GM
MINES AND GEOLOGICAL DEPT.
NAIROBI - KENYA

I hereby certify that the above particulars are correct for the best of my knowledge and belief and that I/the firm holds(s) current Mineral Dealers licence No. .... Of 20....

DATE 1/11/2012

SIGNATURE OF CONSIGNER

Permission is hereby granted to

M/s NATIONAL MUSEUM OF KENYA

To export the Minerals(s) whose particulars are specified herein above within the period of fourteen (14) days from the date thereof,

Dated the 1ST day of NOVEMBER 20 12

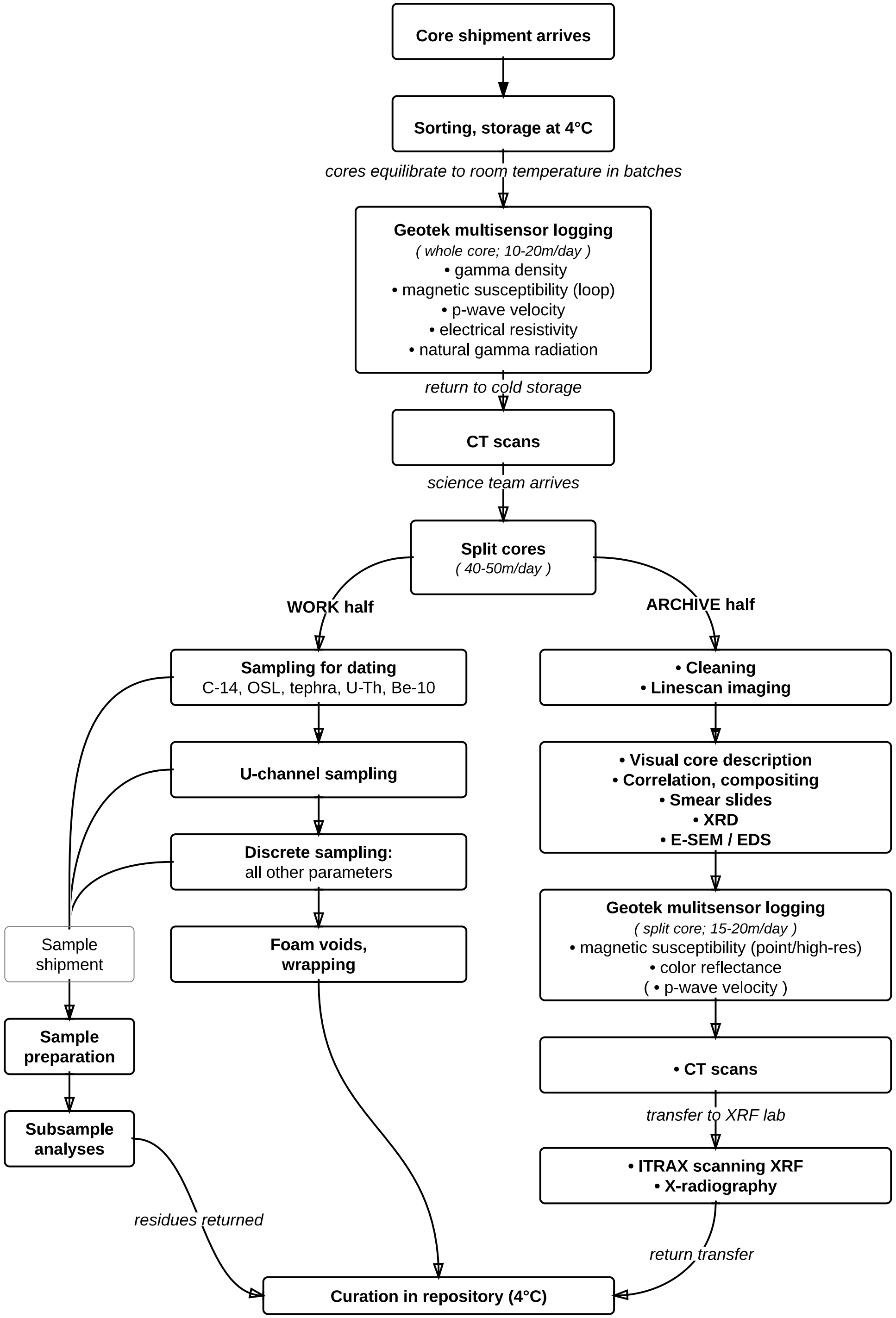
COMMISSIONER OF MINES AND GEOLOGY

For: Commissioner of Mines & Geology

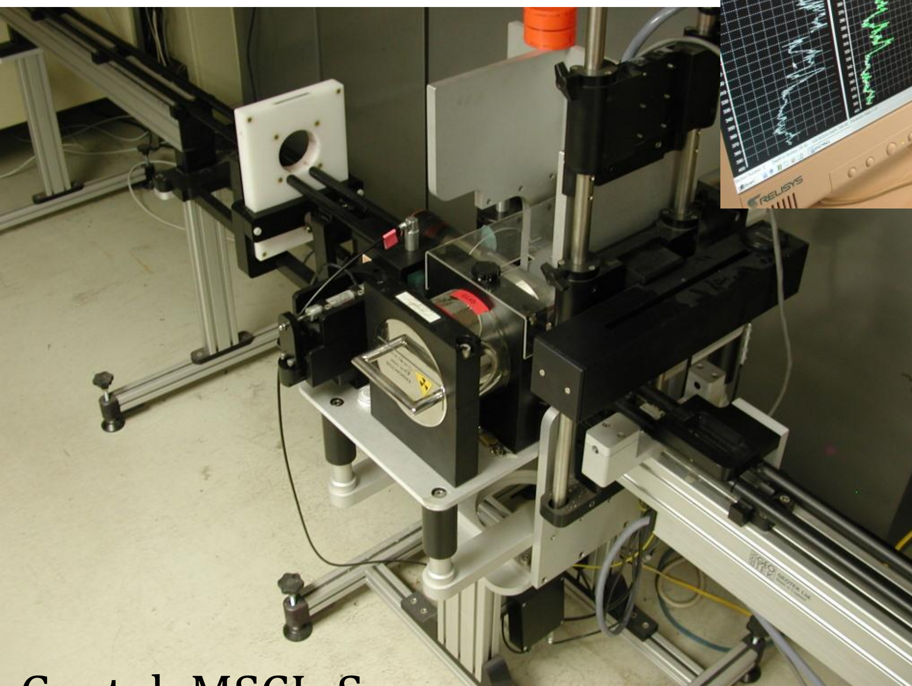
Lab Core Processing Workflow

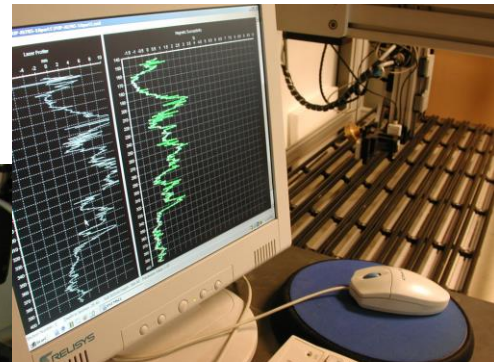
- Adaptable
- Proposal details ideal case
- Specifics determined post-drilling, prior to core party
- Recognize incompatibilities (e.g. OSL after XRF / XR / CT)

Goals:
Process all cores rapidly
Nondestructive analyses first
Prioritize chronology
Distribute samples immediately
Preserve sediment in tubes
Manage data



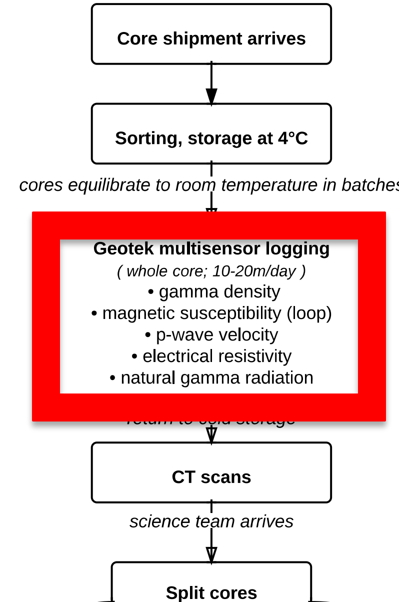
Multisensor Logging

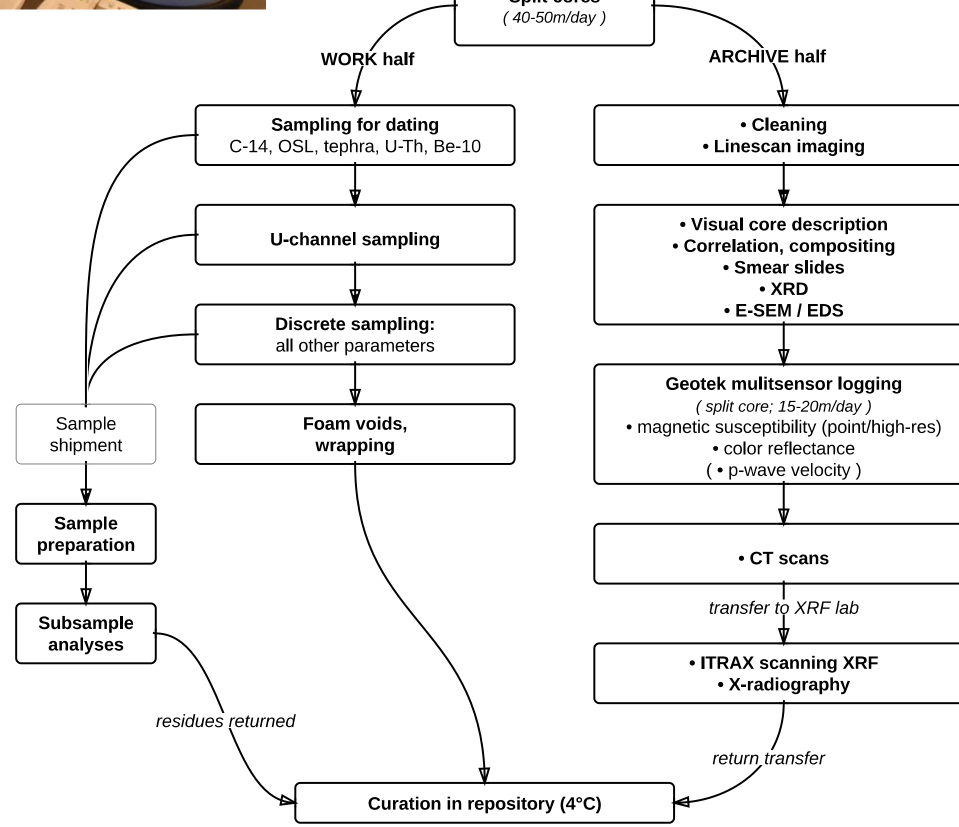




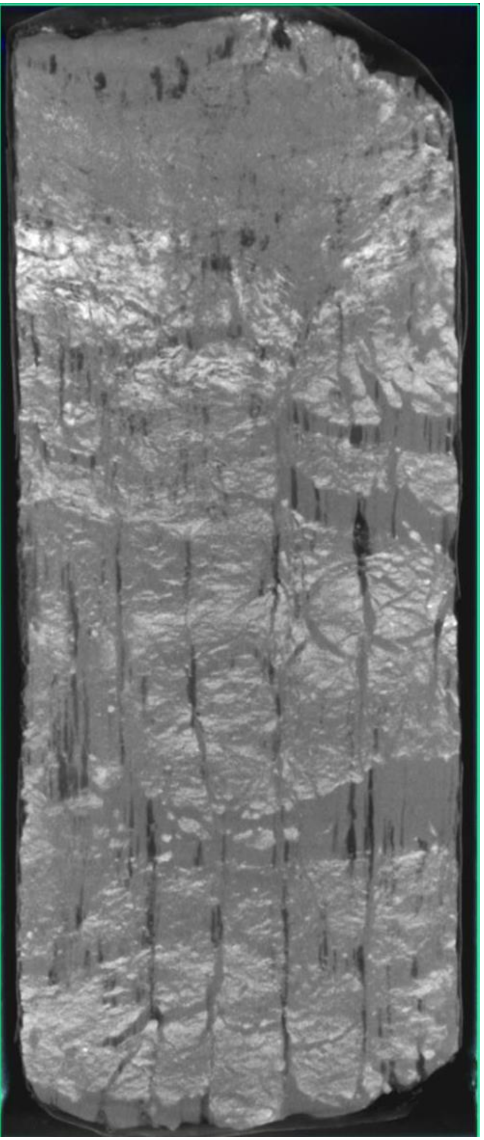
Geotek MSCL-S

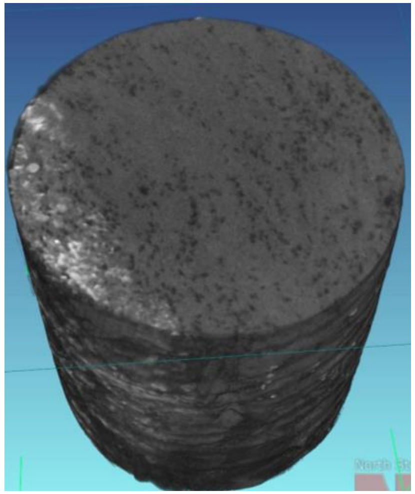
- gamma density
- p-wave velocity
- electrical resistivity
- magnetic susceptibility (loop)
- natural gamma radiation

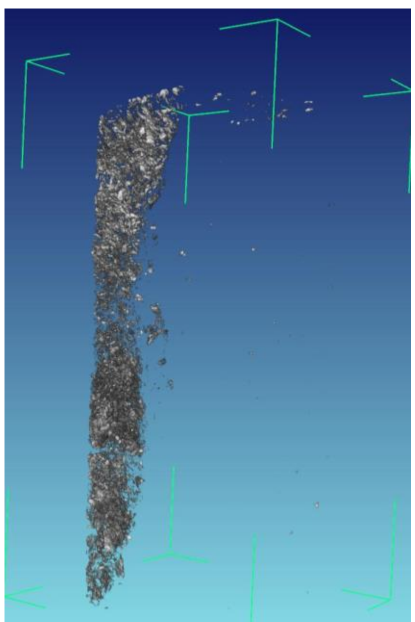


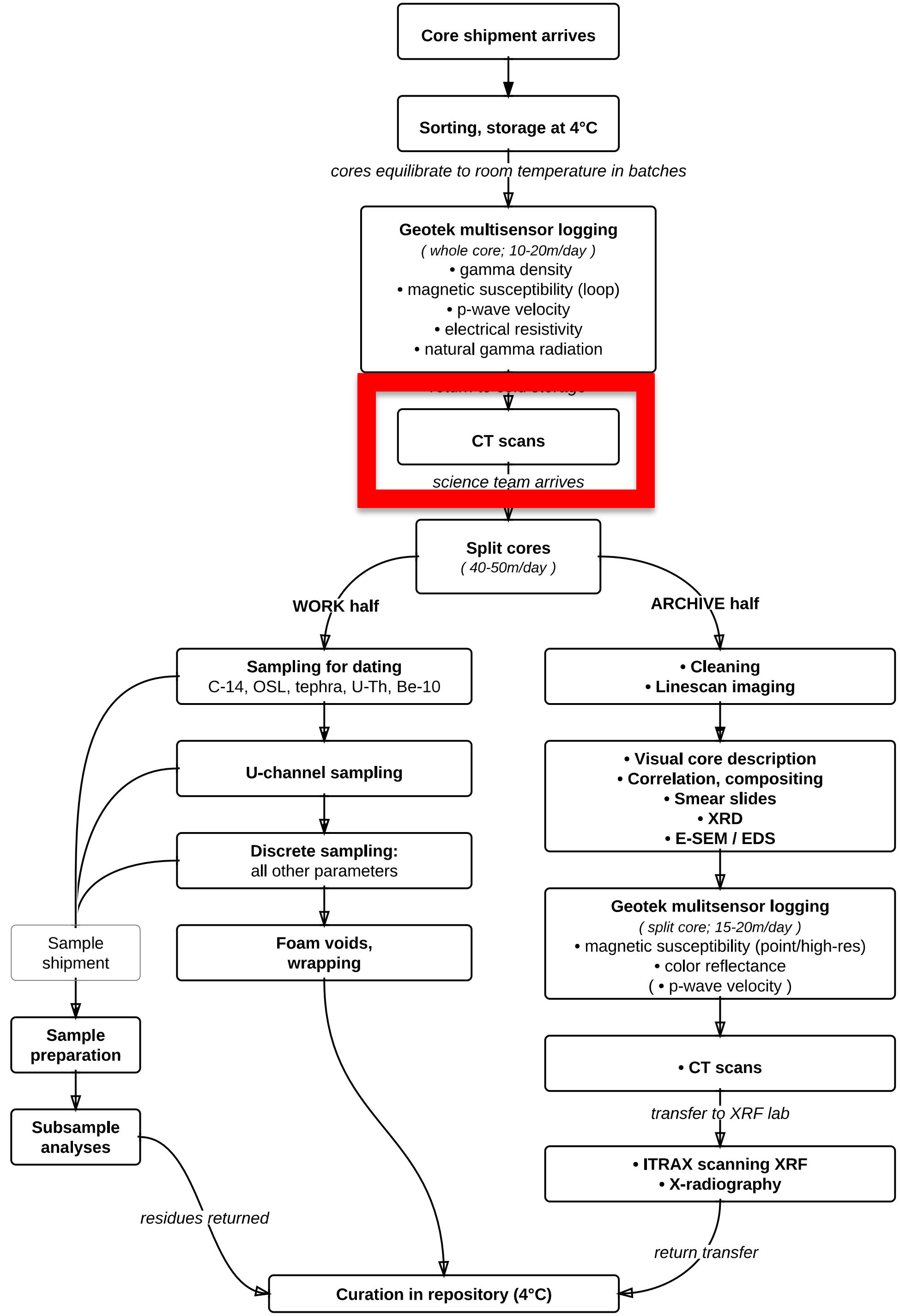


CT Scans



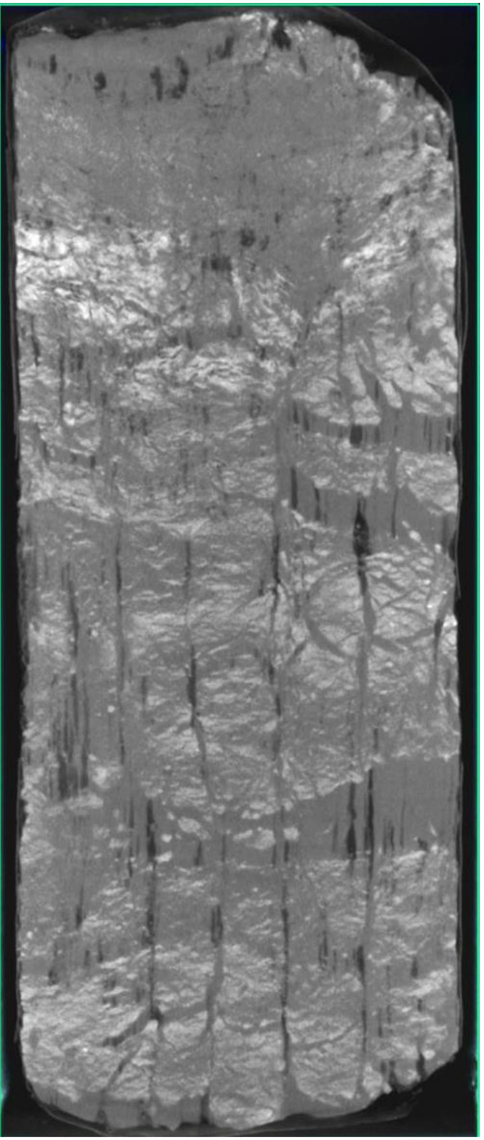


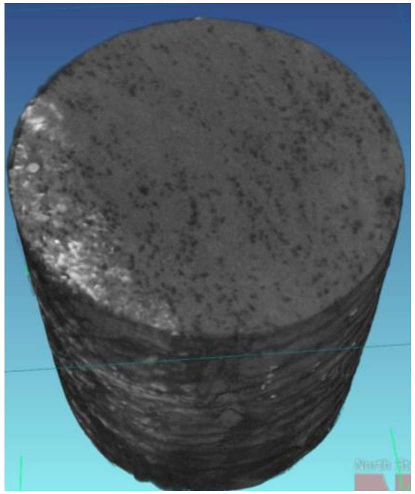


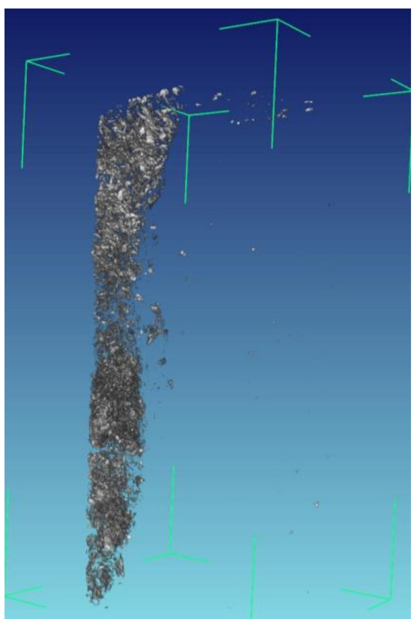


Core shipment arrives
Sorting, storage at 4°C
cores equilibrate to room temperature in batches
Geotek multisensor logging
(whole core; 10-20m/day)
• gamma density
• magnetic susceptibility (loop)
• p-wave velocity
• electrical resistivity
• natural gamma radiation
CT scans
science team arrives
Split cores
(40-50m/day)
WORK half
ARCHIVE half
Sampling for dating
C-14, OSL, tephra, U-Th, Be-10
U-channel sampling
Discrete sampling:
all other parameters
Foam voids,
wrapping
Sample
shipment
Sample
preparation
Subsample
analyses
residues returned
• Cleaning
• Linescan imaging
• Visual core description
• Correlation, compositing
• Smear slides
• XRD
• E-SEM / EDS
Geotek mulitsensor logging
(split core; 15-20m/day)
• magnetic susceptibility (point/high-res)
• color reflectance
(• p-wave velocity)
• CT scans
transfer to XRF lab
• ITRAX scanning XRF
• X-radiography
return transfer
Curation in repository (4°C)

CT Scans





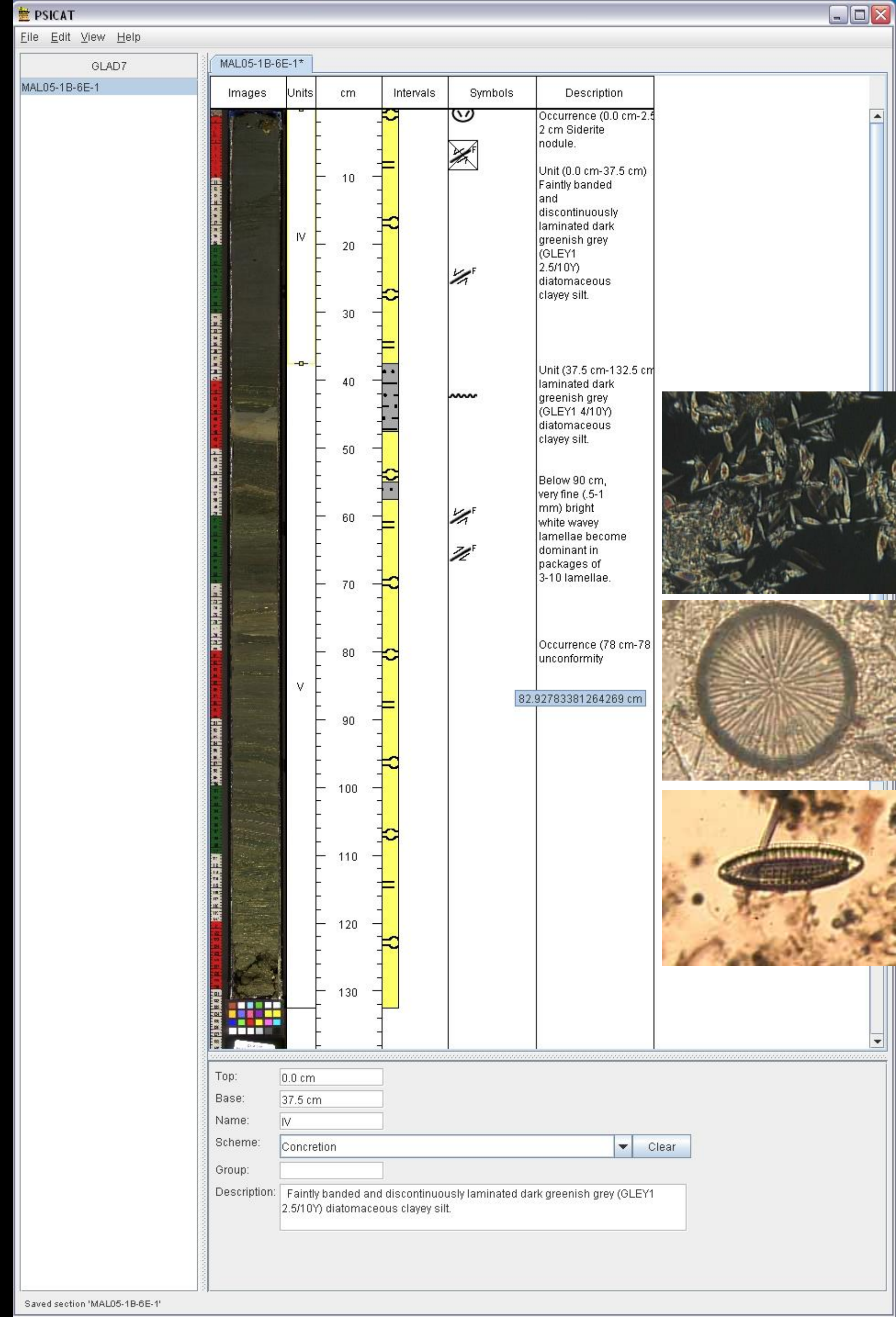


- Create 3D image of core contents
- Isolate / locate densities (components) of interest: dropstones, concretions, fish fossils, etc
- Slow
- Expensive
- Incompatible with OSL dating

Splitting

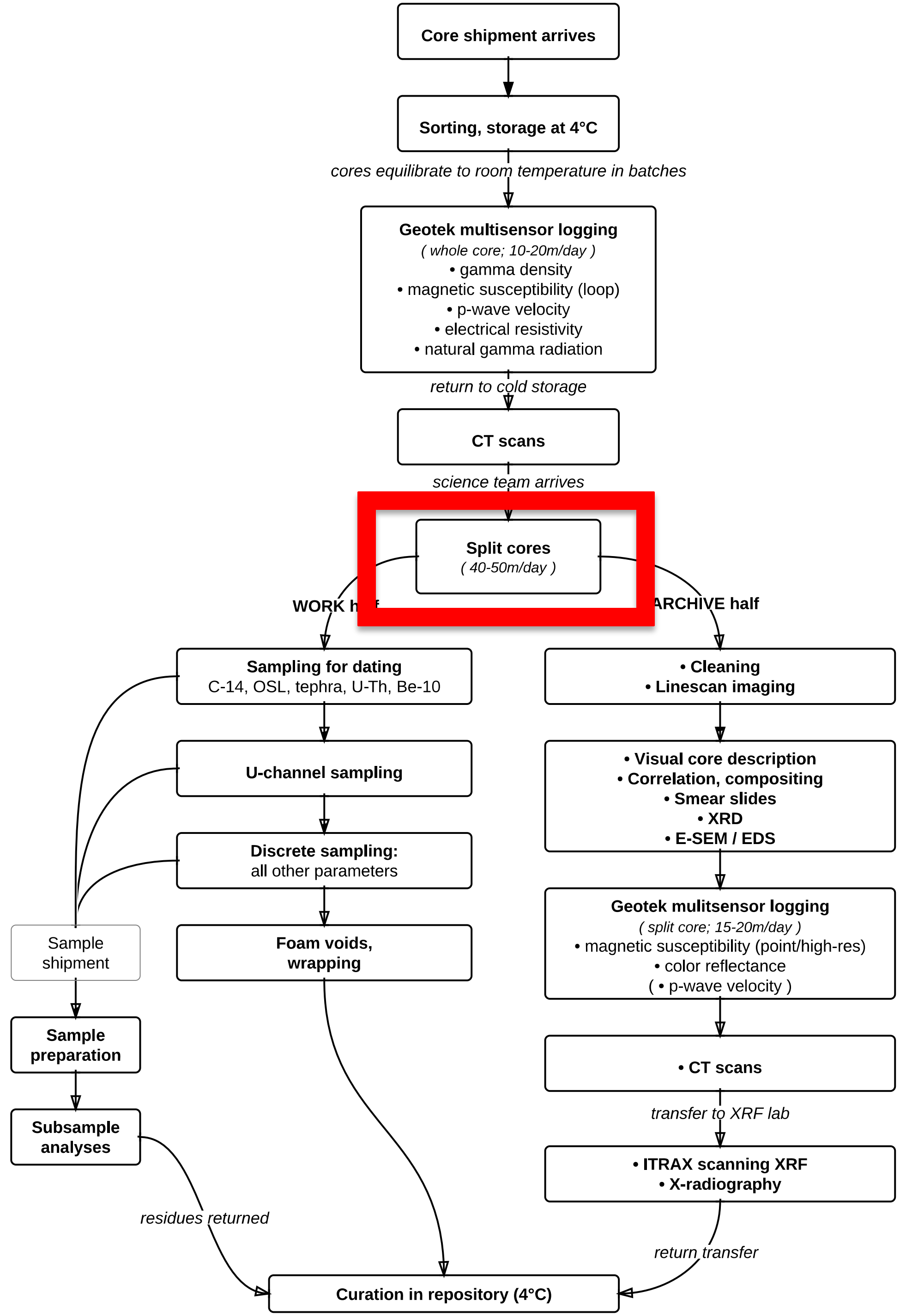
- Project scientists reconvene
- Split, describe cores
- 30-50m / 12 hr

Personnel: 6 to 12 (depending on sampling)



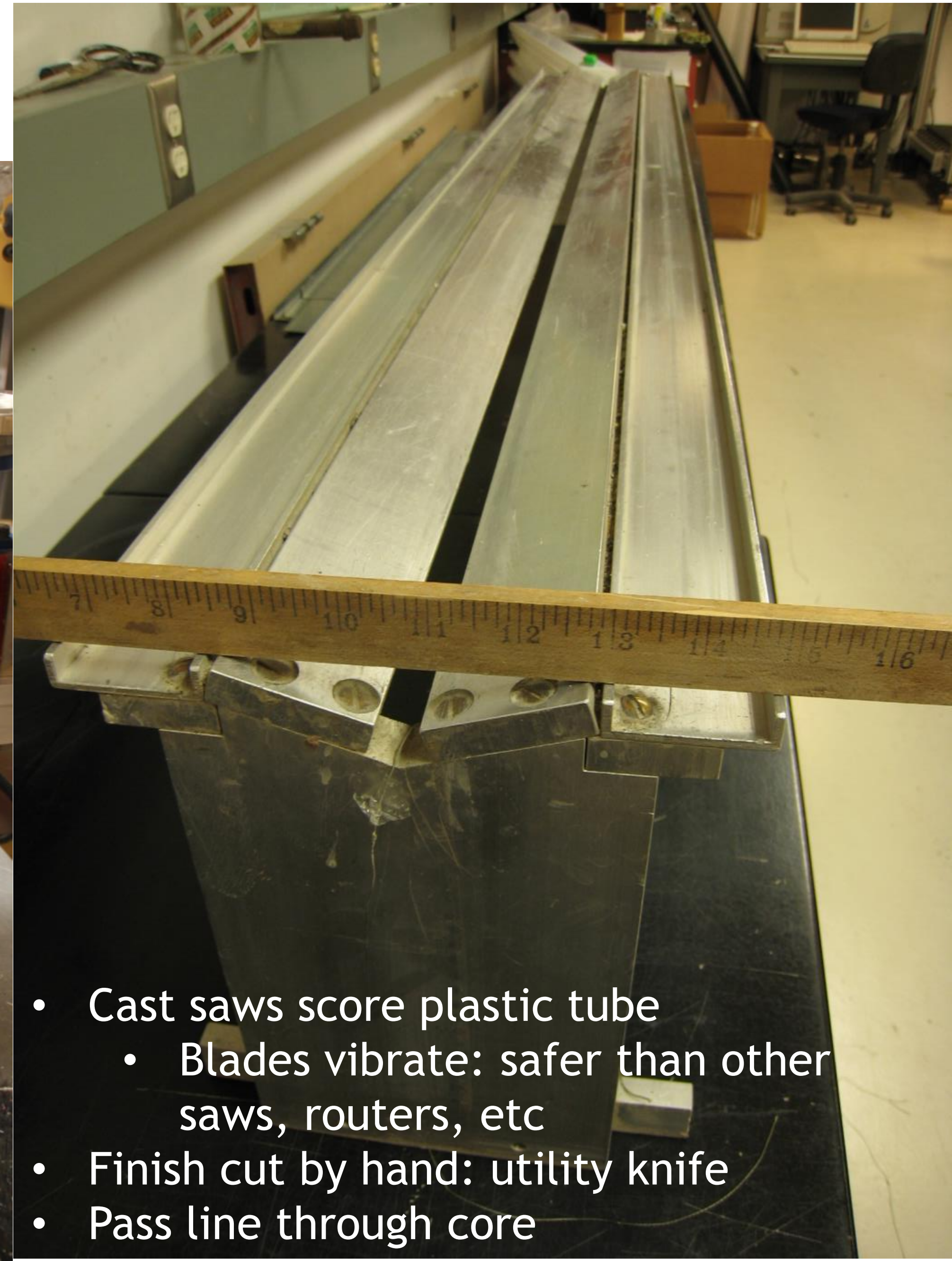
Core Splitting

Soft sediment



Core Splitting

Soft sediment



- Cast saws score plastic tube
    - Blades vibrate: safer than other saws, routers, etc
- Finish cut by hand: utility knife
- Pass line through core

Core Splitting

Harder, drier sediment

- Band saw cuts core and liner in one pass
- Diamond-grit blade
- Aggressive core cleaning required
- Cores cannot be dry
- Use:
  - Evaporites
  - Peats
  - Dropstones
  - Desiccation surfaces
  - Concretions / nodules
  - Depths where line-cutting shatters sediment

Core Splitting

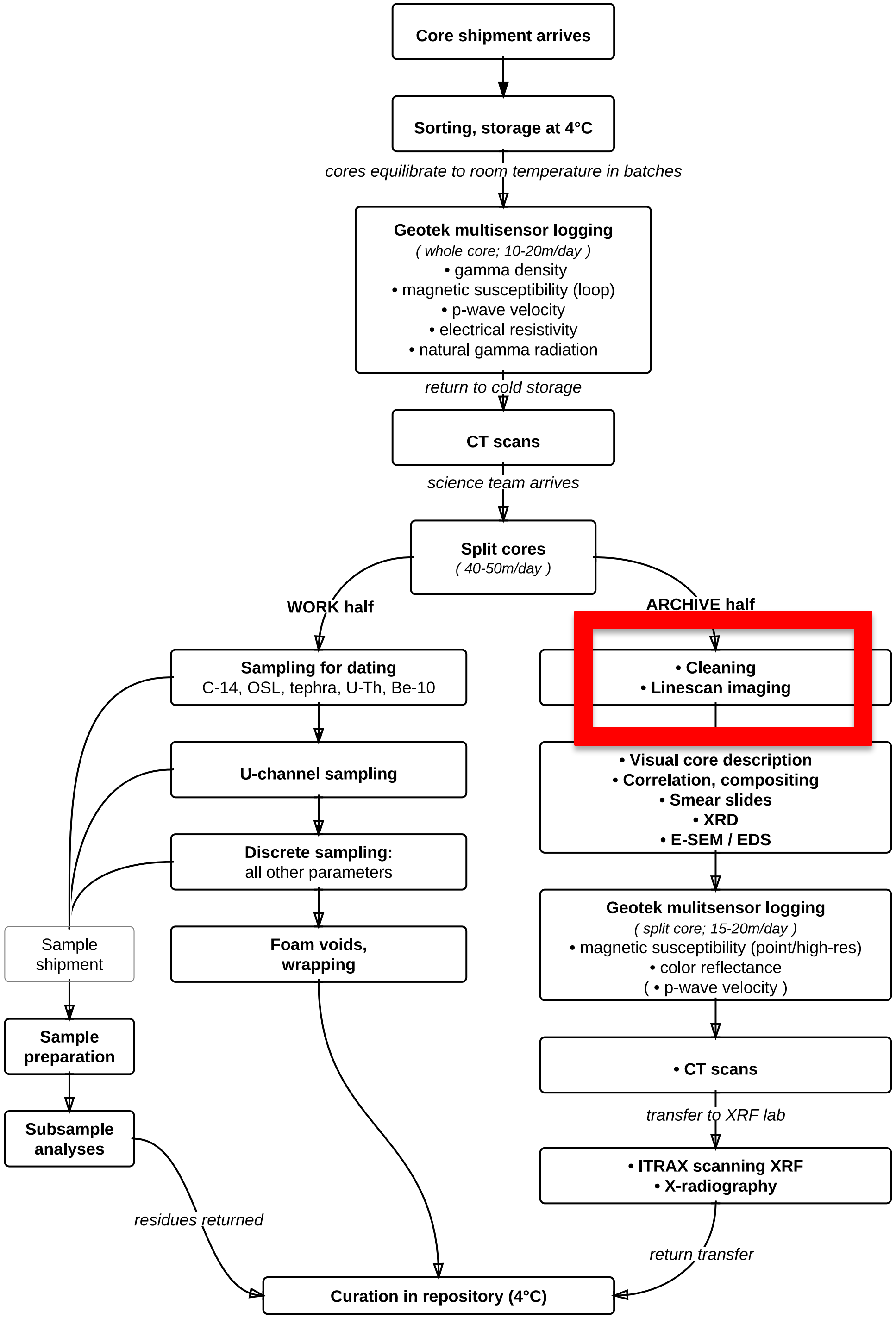
Dry / lithified cores

- Rock/tile saw cuts liner and core
- Air-cooled blades
- Water-cooled blades
- Use:
  - Dry / lithified cores

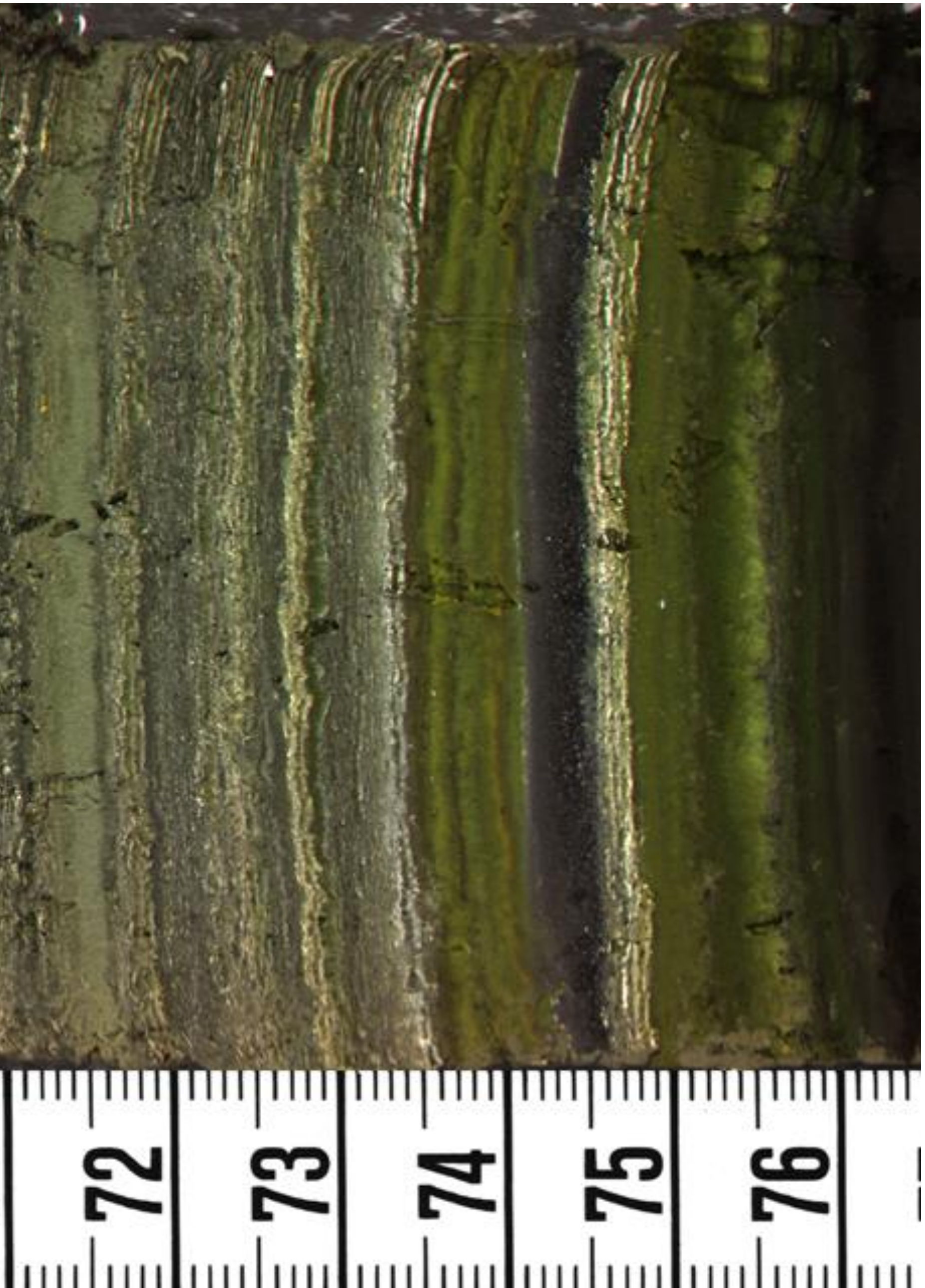
Cleaning

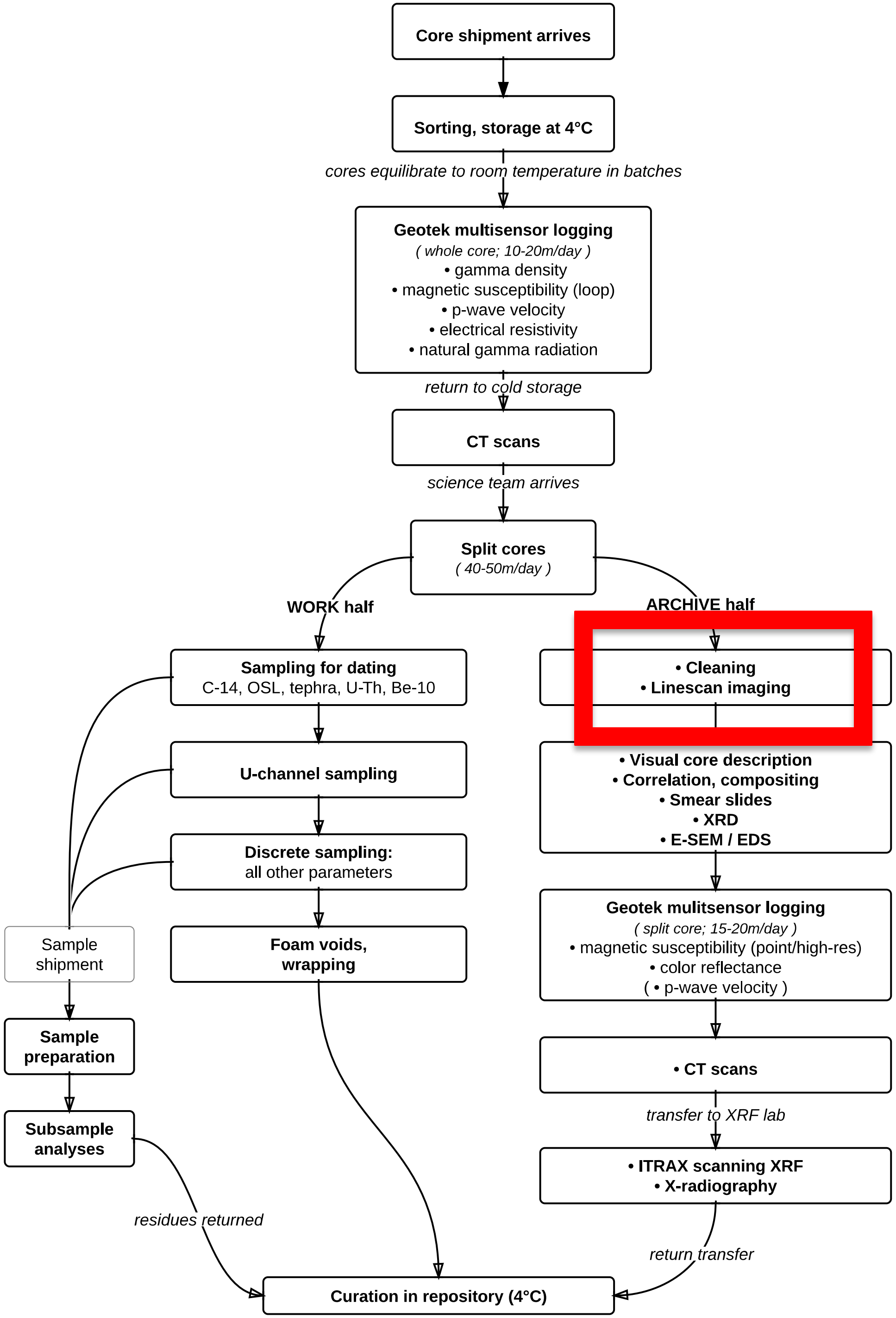
- Glass microscope slides, with corners rounded
- Scrape across core, parallel to bedding
- Wipe scraper on wet rag

- Spray lithified cores

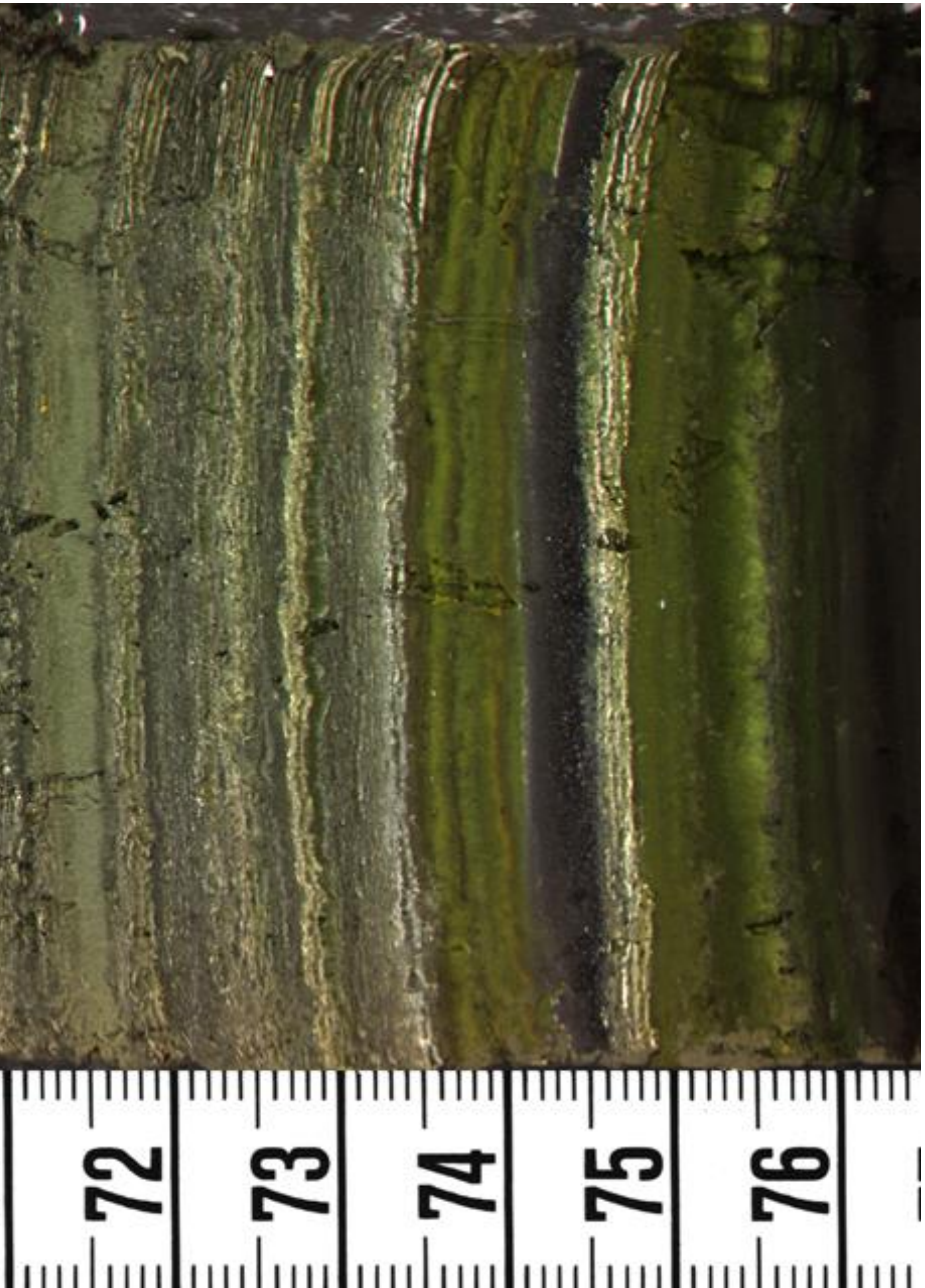


Linescan Imaging





Linescan Imaging

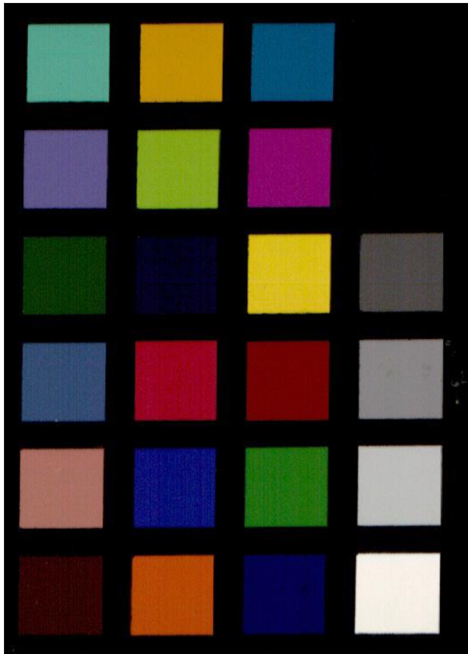


- 50 micron resolution
- Cross-polarized light: eliminate glare
- Permanent high-res record of fresh lithology
- Basis for descriptions and reference for all numerical datasets
- Calibrated color reference card in images permits post-processing to:
  - Equalize exposure across images
  - Calibrate color for accurate rendering

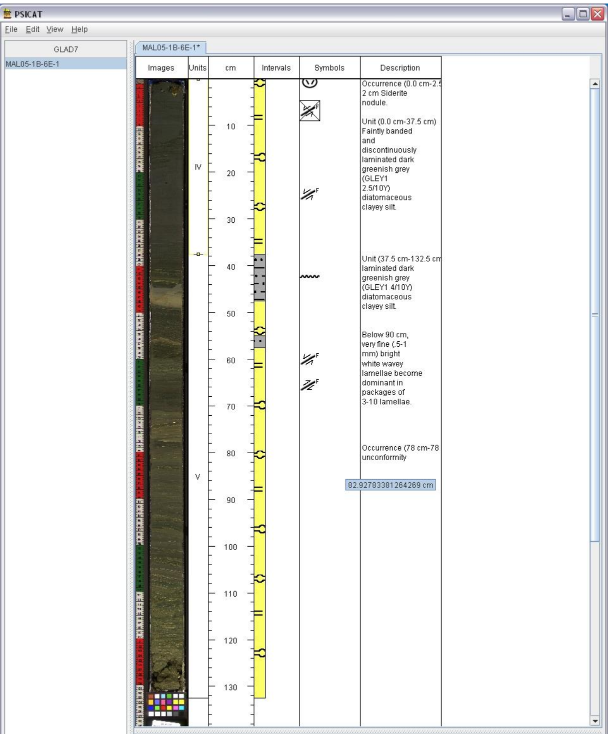
The data below is intended to be an average measurement of all ColorChecker Charts. ColorChecker Charts should be replaced every two years as fading of the colors will alter the values of the chart.

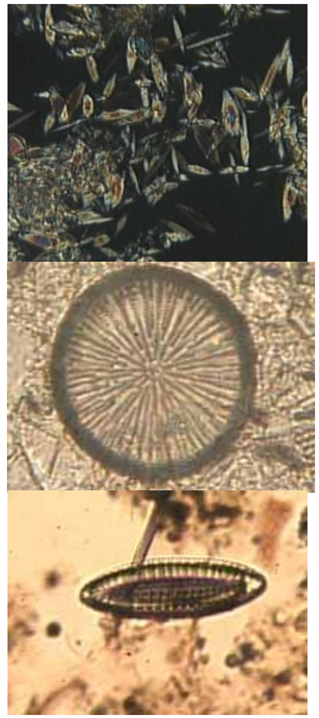
No.	Number	sRGB R	sRGB G	sRGB B	CIE L*a*b* L*	CIE L*a*b* a*	CIE L*a*b* b*	Munsell Notation Hue	Value / Chroma
1.	dark skin	115	82	68	37.986	13.555	14.059	3 YR	3.7 / 3.2
2.	light skin	194	150	130	65.711	18.13	17.81	2.2 YR	6.47 / 4.1
3.	blue sky	98	122	157	49.927	-4.88	-21.925	4.3 PB	4.95 / 5.5
4.	foliage	87	108	67	43.139	-13.095	21.905	6.7 GY	4.2 / 4.1
5.	blue flower	133	128	177	55.112	8.844	-25.399	9.7 PB	5.47 / 6.7
6.	bluish green	103	189	170	70.719	-33.397	-0.199	2.5 BG	7 / 6
7.	orange	214	126	44	62.661	36.067	57.096	5 YR	6 / 11
8.	purplish blue	80	91	166	40.02	10.41	-45.964	7.5 PB	4 / 10.7
9.	moderate red	193	90	99	51.124	48.239	16.248	2.5 R	5 / 10
10.	purple	94	60	108	30.325	22.976	-21.587	5 P	3 / 7
11.	yellow green	157	188	64	72.532	-23.709	57.255	5 GY	7.1 / 9.1
12.	orange yellow	224	163	46	71.941	19.363	67.857	10 YR	7 / 10.5
13.	blue	56	61	150	28.778	14.179	-50.297	7.5 PB	2.9 / 12.7
14.	green	70	148	73	55.261	-38.342	31.37	0.25 G	5.4 / 8.65
15.	red	175	54	60	42.101	53.378	28.19	5 R	4 / 12
16.	yellow	231	199	31	81.733	4.039	79.819	5 Y	8 / 11.1
17.	magenta	187	86	149	51.935	49.986	-14.574	2.5 RP	5 / 12
18.	cyan	8	133	161	51.038	-28.631	-28.638	5 B	5 / 8
19.	white (.05*)	243	243	242	96.539	-0.425	1.186	N	9.5 /
20.	neutral 8 (.23*)	200	200	200	81.257	-0.638	-0.335	N	8 /
21.	neutral 6.5 (.44*)	160	160	160	66.766	-0.734	-0.504	N	6.5 /
22.	neutral 5 (.70*)	122	122	121	50.867	-0.153	-0.27	N	5 /
23.	neutral 3.5 (.1.05*)	85	85	85	35.656	-0.421	-1.231	N	3.5 /
24.	black (1.50*)	52	52	52	20.461	-0.079	-0.973	N	2 /

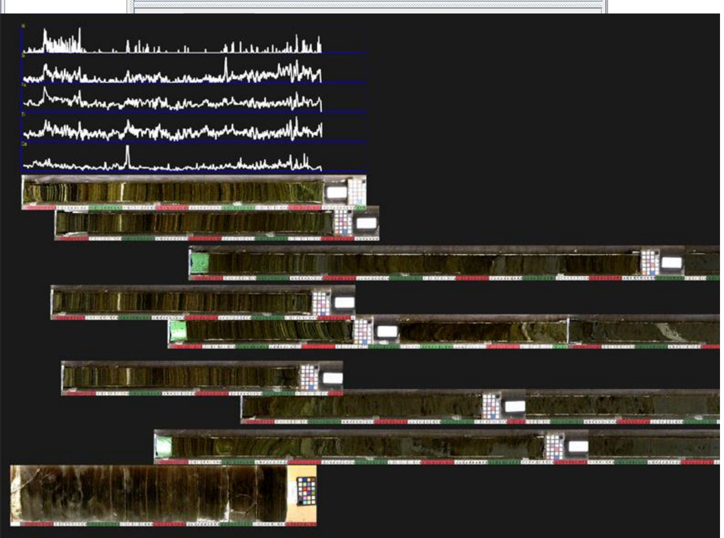
Cie L*a*b* values use Illuminant D50 2 degree observer sRGB values for Illuminate D65.

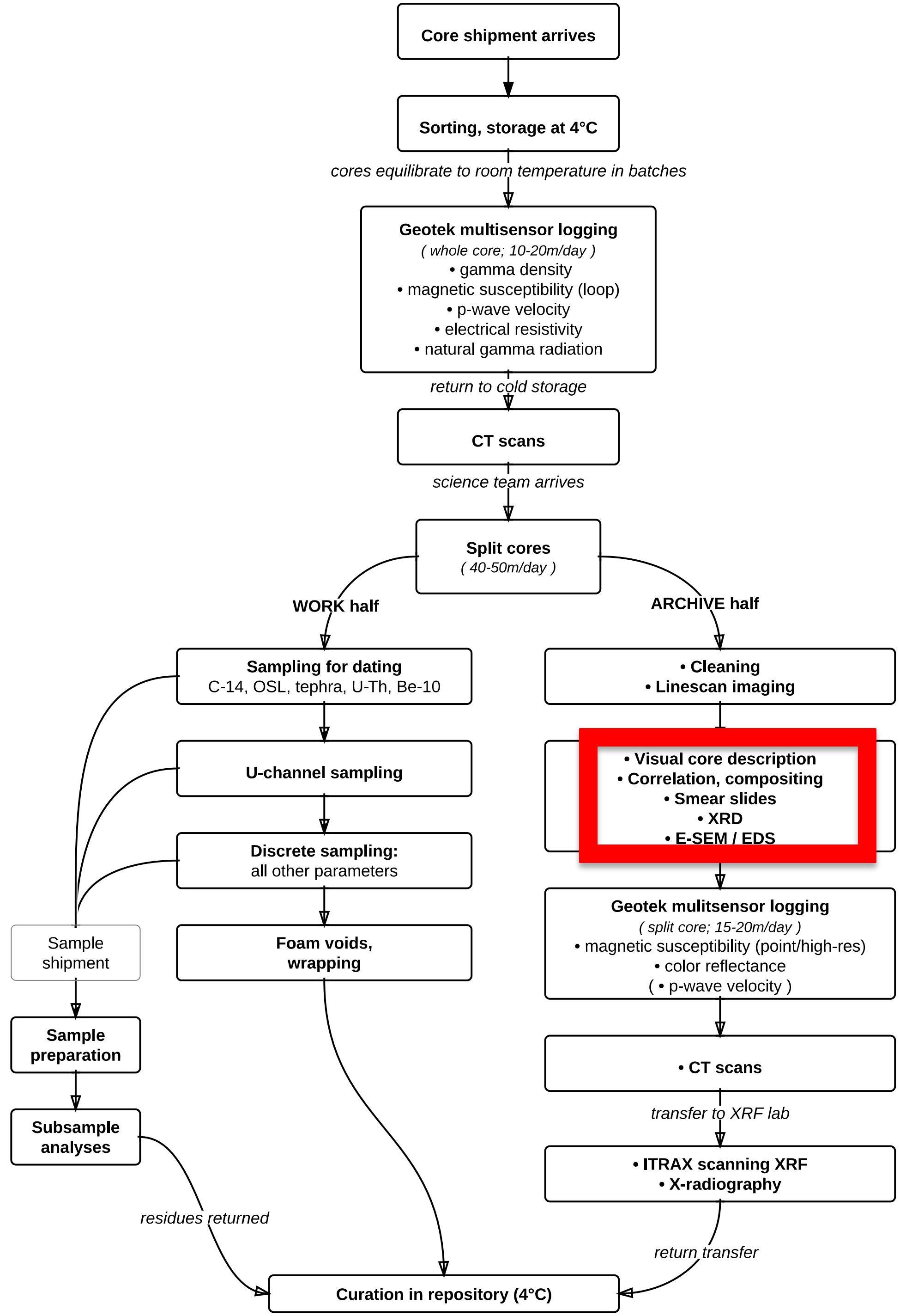


Lithologic Description

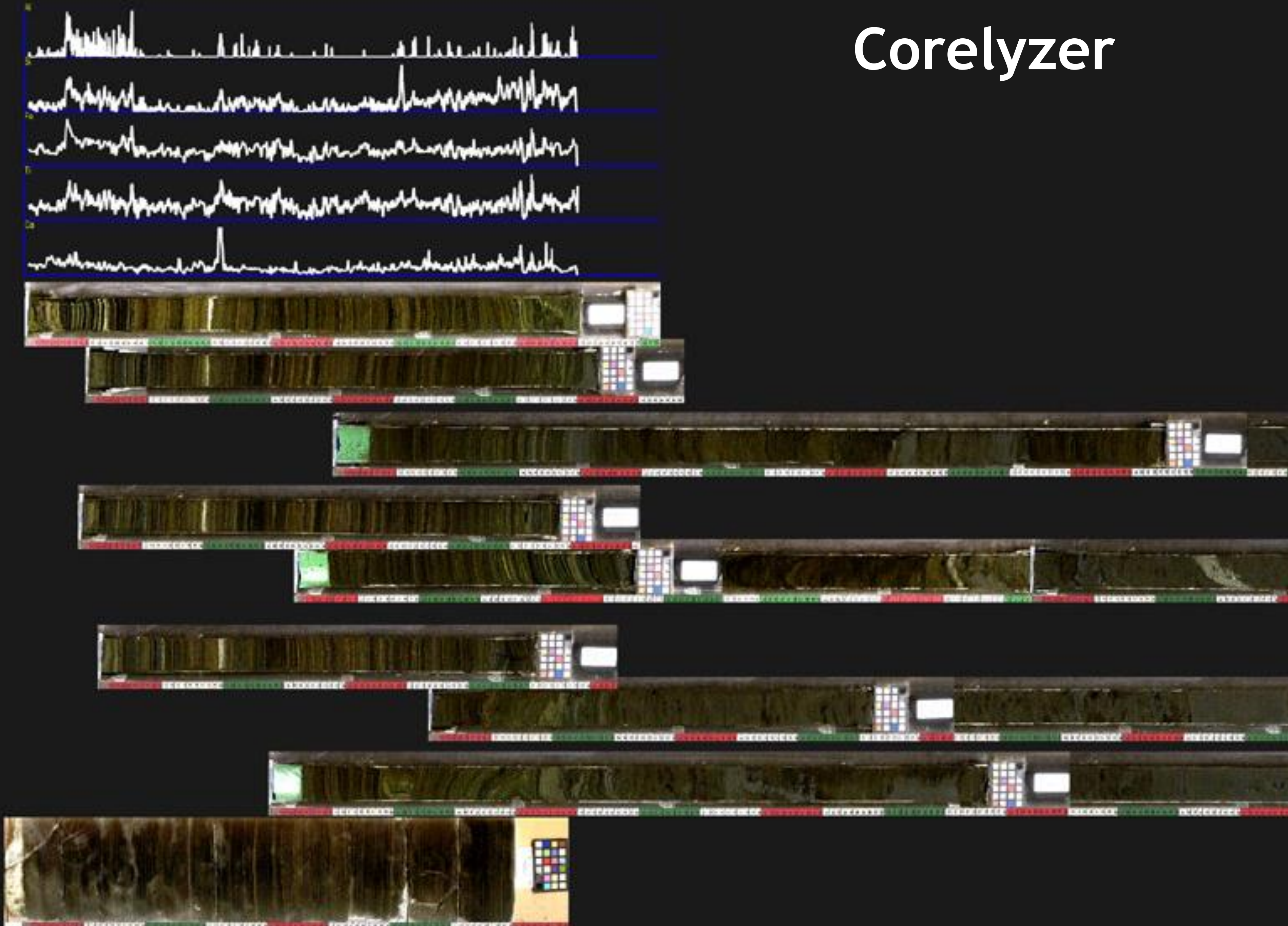


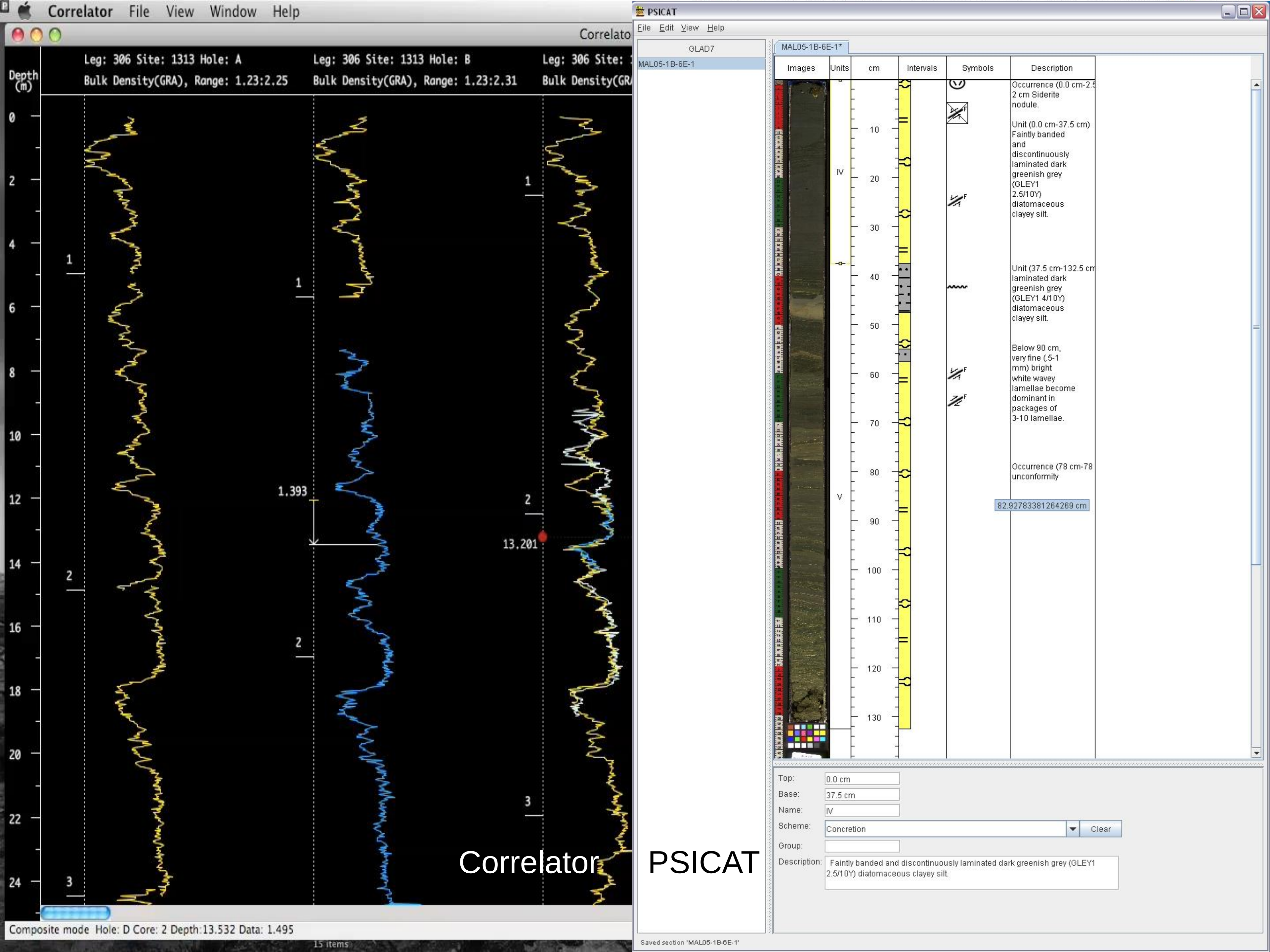


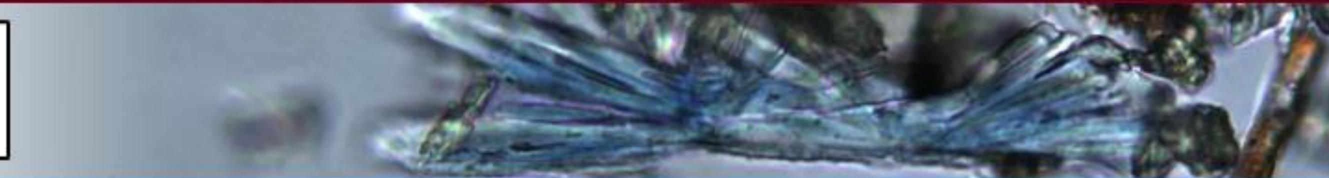




Corelyzer




Correlator File View Window Help
Leg: 306 Site: 1313 Hole: A
Bulk Density(GRA), Range: 1.23:2.25
Leg: 306 Site: 1313 Hole: B
Bulk Density(GRA), Range: 1.23:2.31
Depth (m)
1.393
13.201
Composite mode Hole: D Core: 2 Depth:13.532 Data: 1.495
Correlator
PSICAT
File Edit View Help
GLAD7
MAL05-1B-6E-1
Images
Units
cm
Intervals
Symbols
Description
Occurrence (0.0 cm-2.5
2 cm Siderite
nodule.
Unit (0.0 cm-37.5 cm)
Faintly banded and discontinuously laminated dark greenish grey (GLEY1 2.5/10Y) diatomaceous clayey silt.
Unit (37.5 cm-132.5 cm
laminated dark greenish grey (GLEY1 4/10Y) diatomaceous clayey silt.
Below 90 cm, very fine (.5-1 mm) bright white wavey lamellae become dominant in packages of 3-10 lamellae.
Occurrence (78 cm-78
unconformity
82.92783381264269 cm
Top: 0.0 cm
Base: 37.5 cm
Name: IV
Scheme: Concretion
Clear
Group:
Description: Faintly banded and discontinuously laminated dark greenish grey (GLEY1 2.5/10Y) diatomaceous clayey silt.
Saved section 'MAL05-1B-6E-1'



Tool for Microscopic Identification

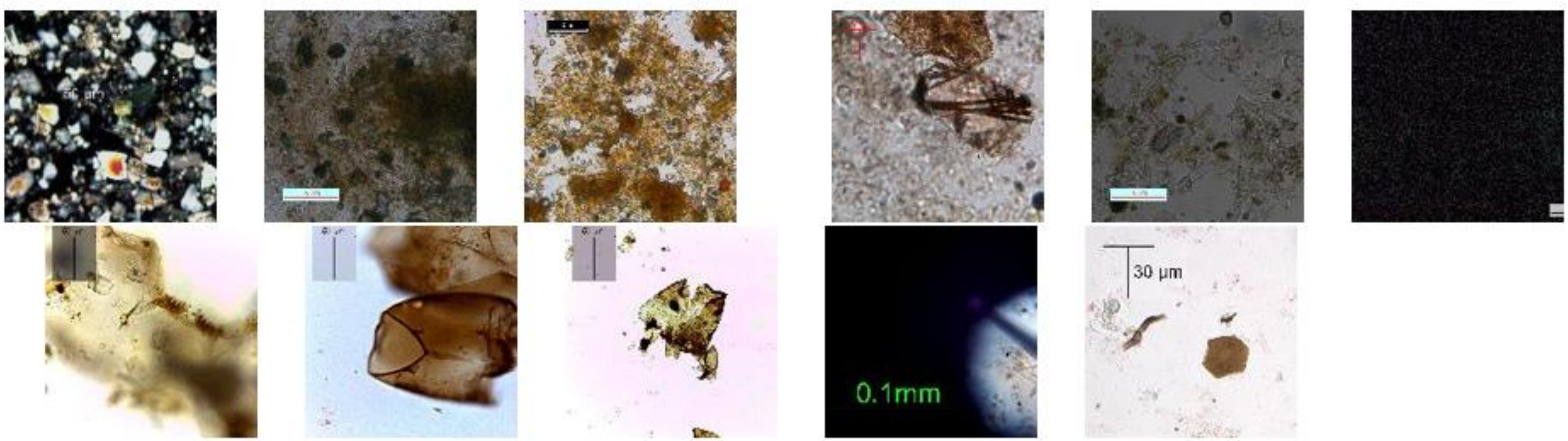
Smear slides are a simple and powerful tool for the characterization of unconsolidated sediment. Used as a part of visual core descripton, they provide a tremendous amount of information about past depositional environments, geochemistry and mineralogy, and flora and fauna.

TMI is designed to help the novice or expert identify sedimentary components as viewed in the polarizing light (petrographic) microscope, with reflected light as necessary. Our focus is on minerals and mineraloids, but the tool also briefly covers biological components that may be encountered while analyzing smear slides.

This resource grew out of the need for a lacustrine smear slide resource, but TMI includes many components that occur in marine sediments as well.

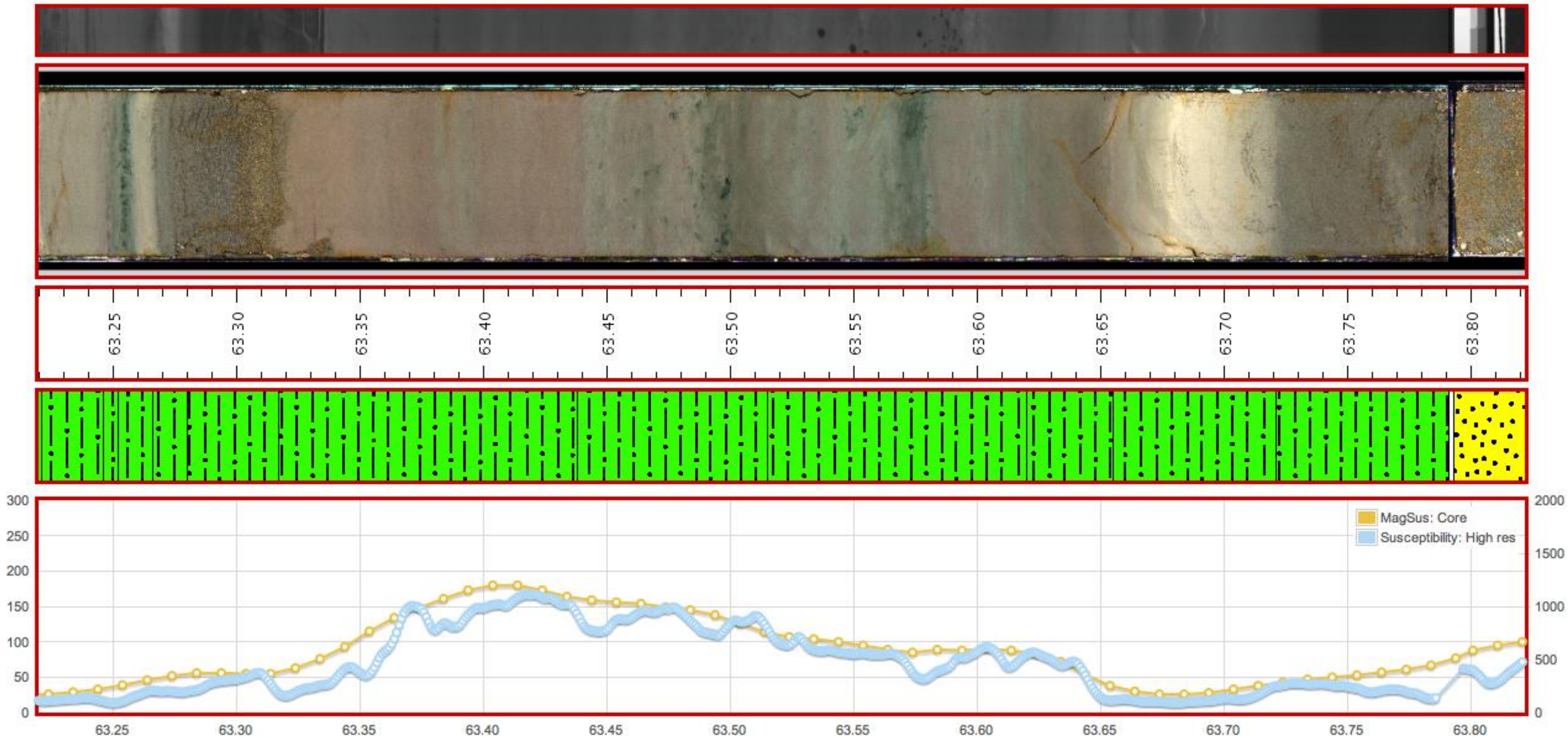
2011 GSA Poster and associated **flyer**

Random Components



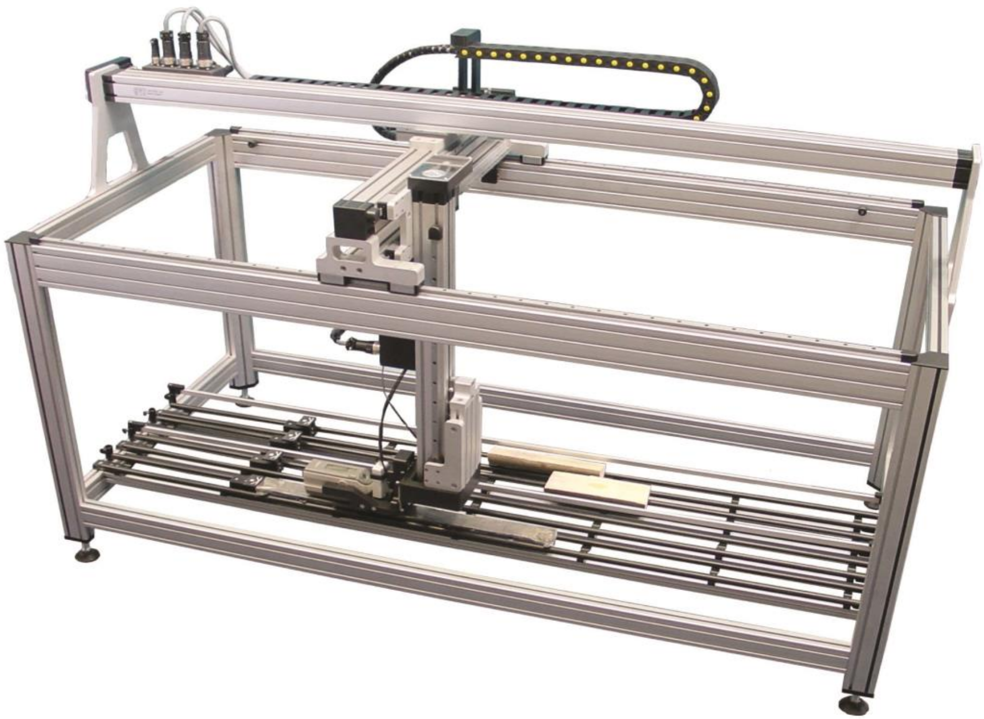
Lake El'gygytgyn Drilling Project - 1A

«



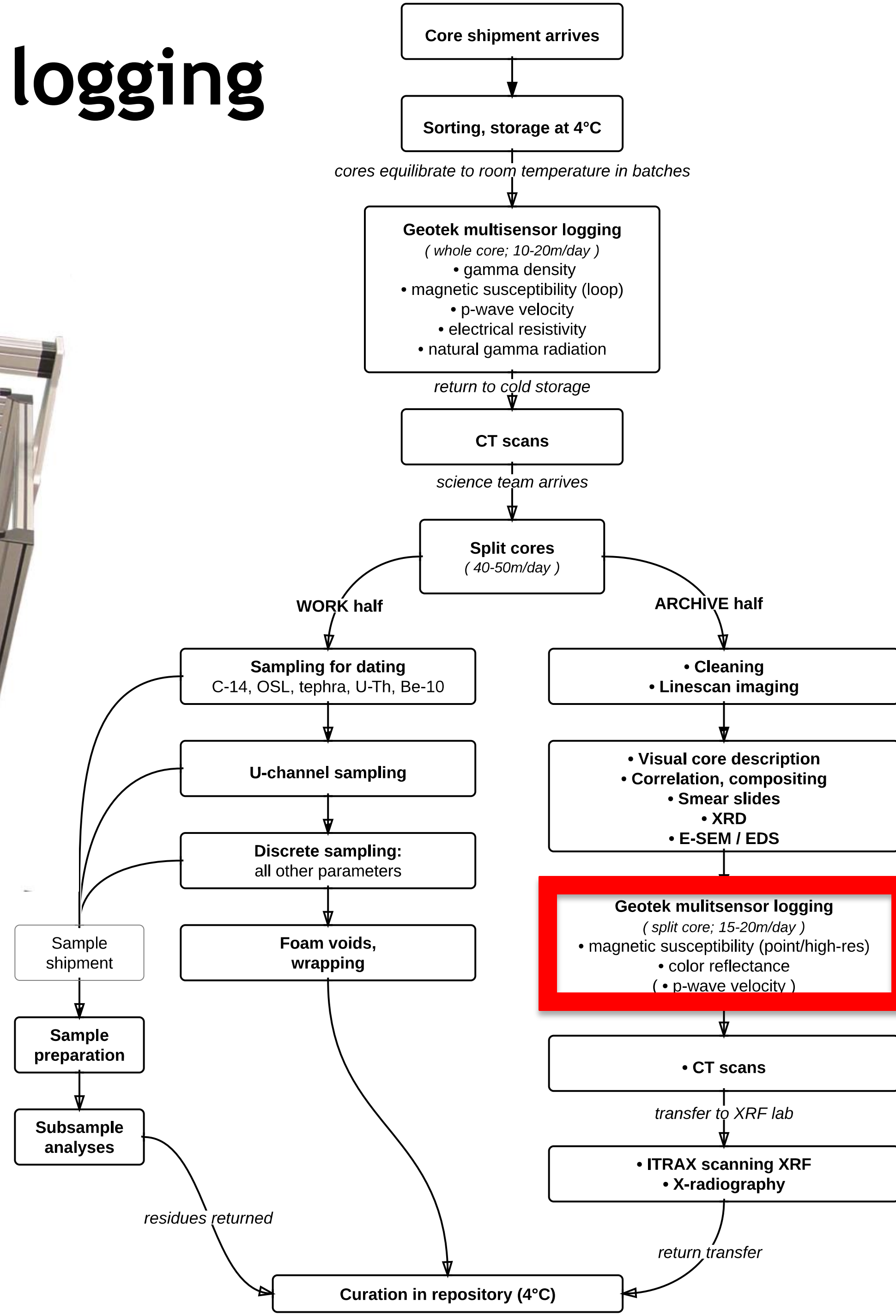
»

Split-core multisensor logging



Geotek MSCL-XYZ

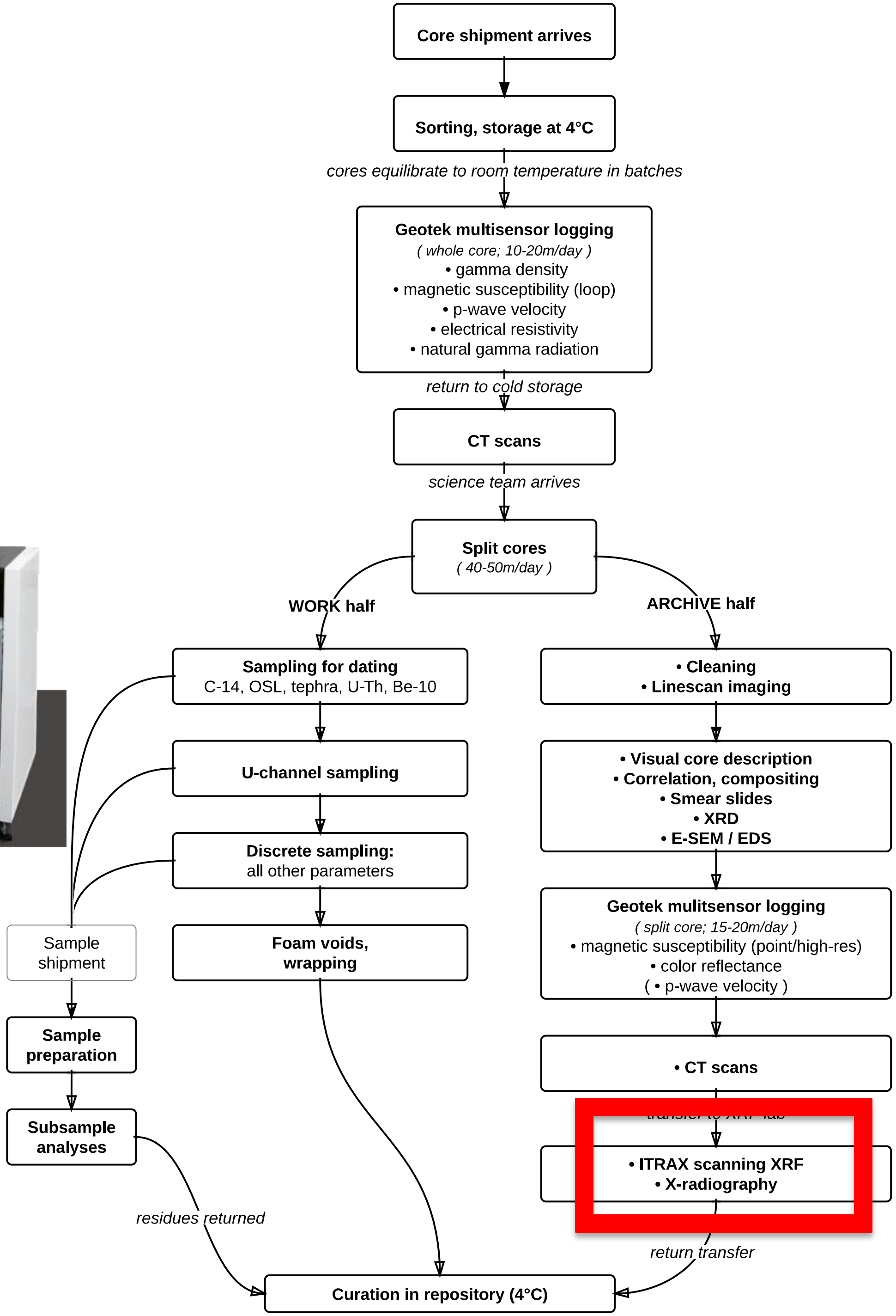
- magnetic susceptibility (point/hi-res)
- color reflectance (360-740nm + L*a*b* and Munsell



Scanning XRF X-radiography

Cox ITRAX

- Concentrations of most elements from Al to U at resolutions to 200 micron
- ~30 to 60 sec/sample interval
- X-radiography: 200 micron resolution; 30 minutes/meter

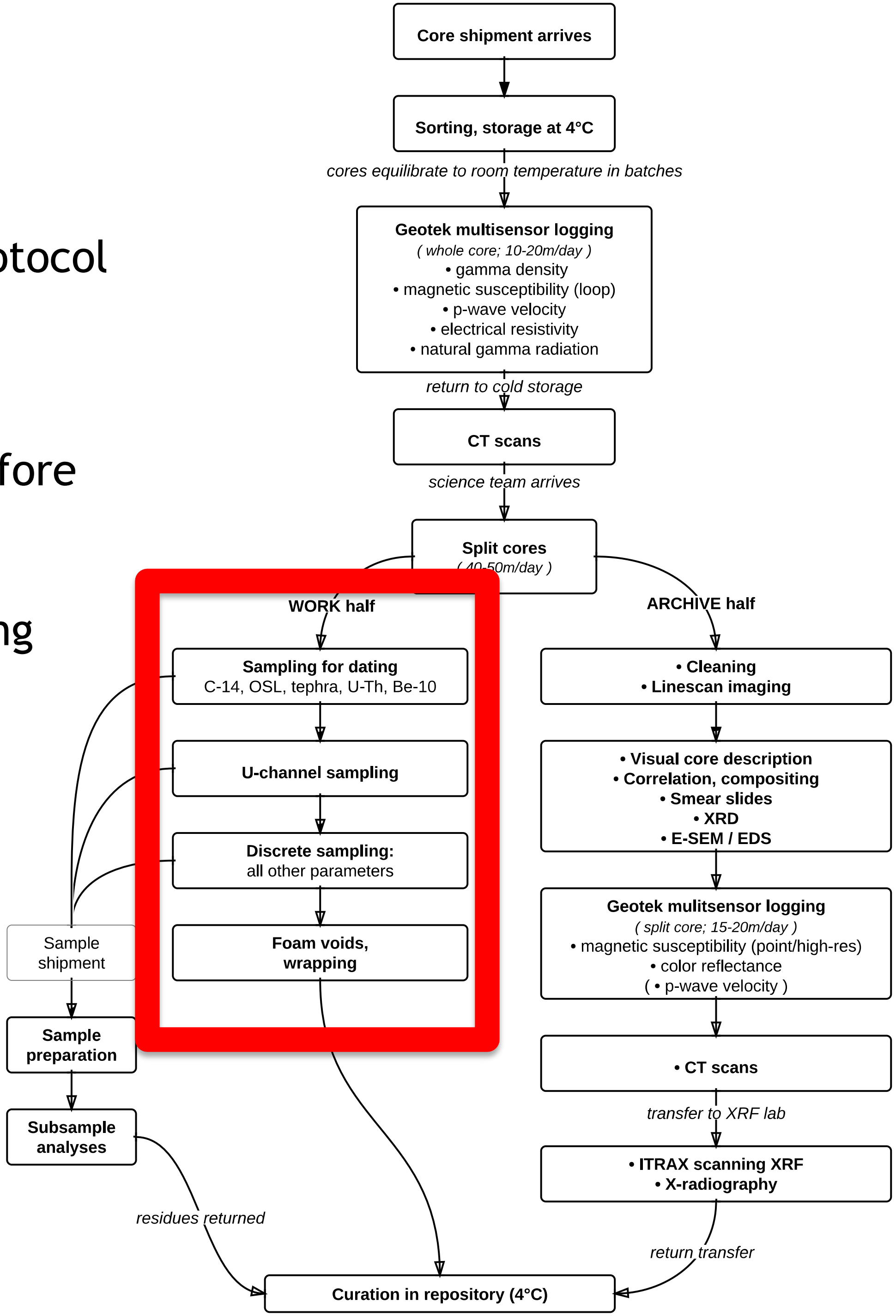


Sampling

Priorities:

1) Meet analytical criteria / optimize protocol
2) Core preservation
3) Speed

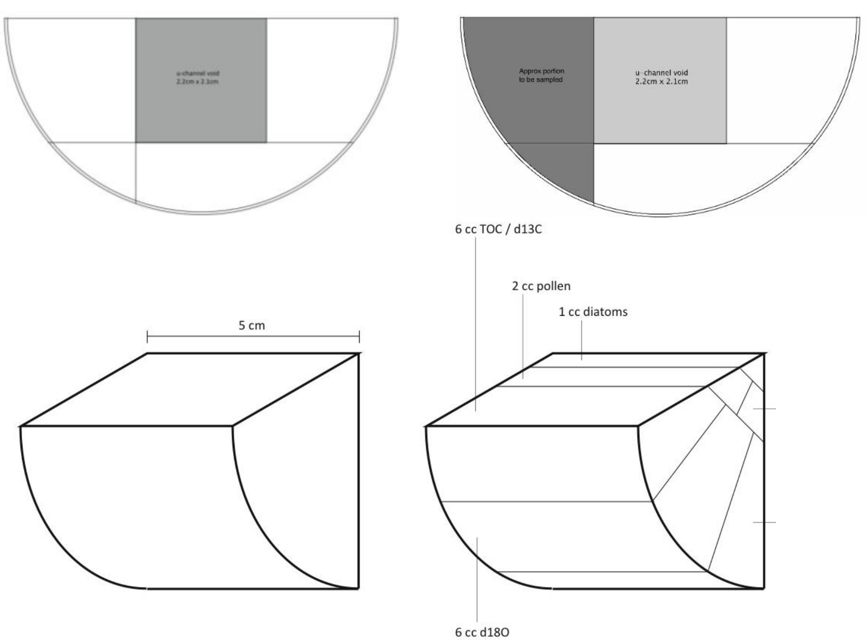
- Establish preliminary sampling plan before drilling: all groups represented
- Revise plan as needed after post-drilling
- Prioritize as in workflow
- Ensure stratigraphic equivalence for paleoenvironmental proxies

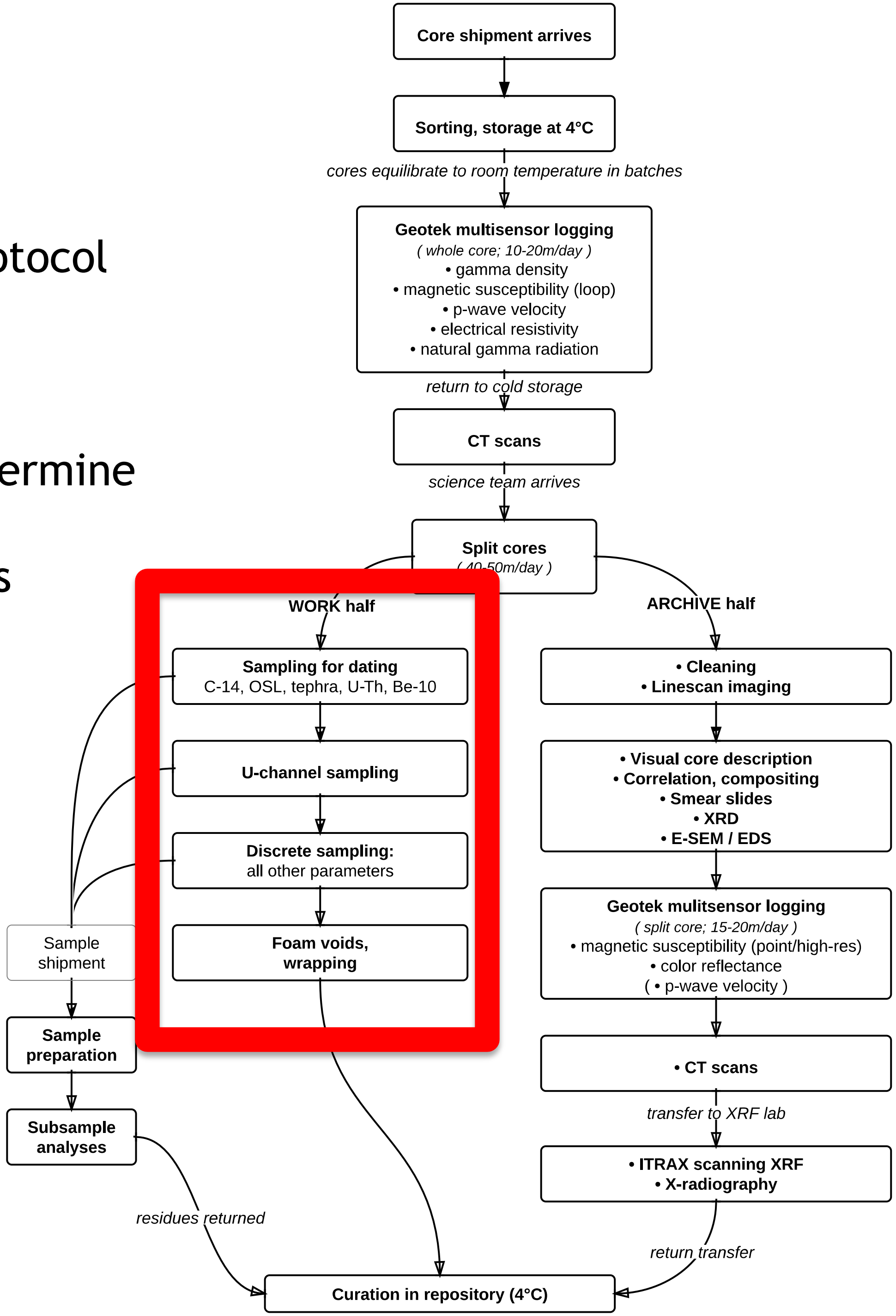


Sampling

Priorities:
1) Meet analytical criteria / optimize protocol
2) Core preservation
3) Speed

- Use minimum sed required; CCs to determine
- Tools (stainless steel):
    - Spatulas, scoops, syringes, discs
    - Sheet metal





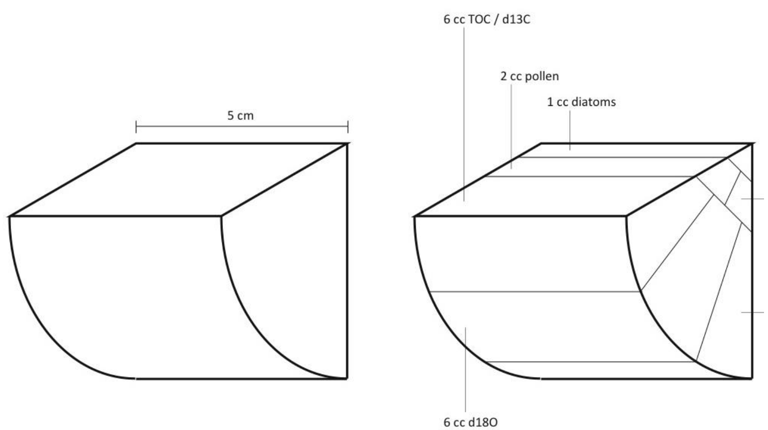
Sampling

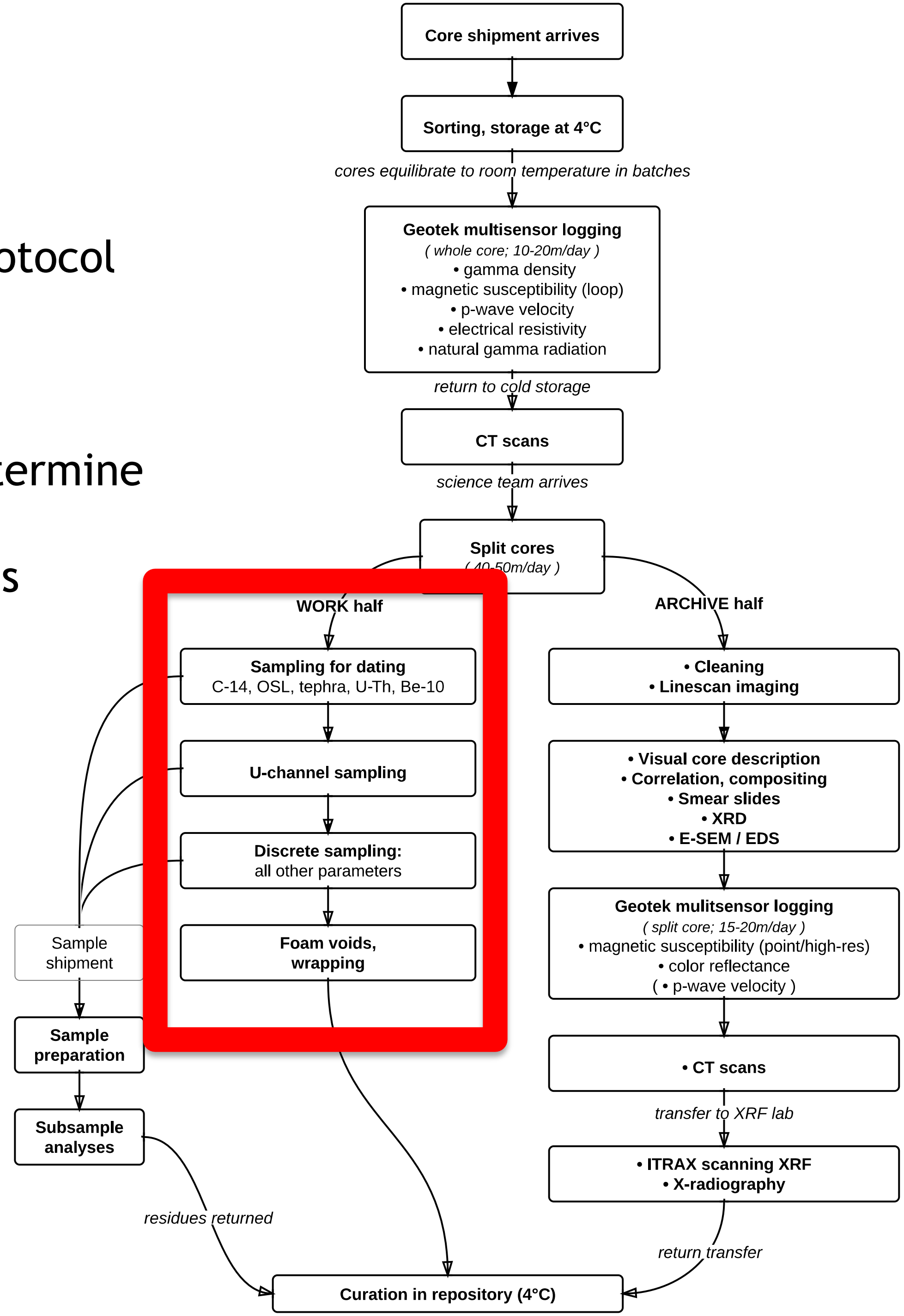
Priorities:

1) Meet analytical criteria / optimize protocol
2) Core preservation
3) Speed

- Use minimum sed required; CCs to determine
- Tools (stainless steel):
    - Spatulas, scoops, syringes, discs
    - Chisel, scroll saw, drill press
- Re-use sample residuals

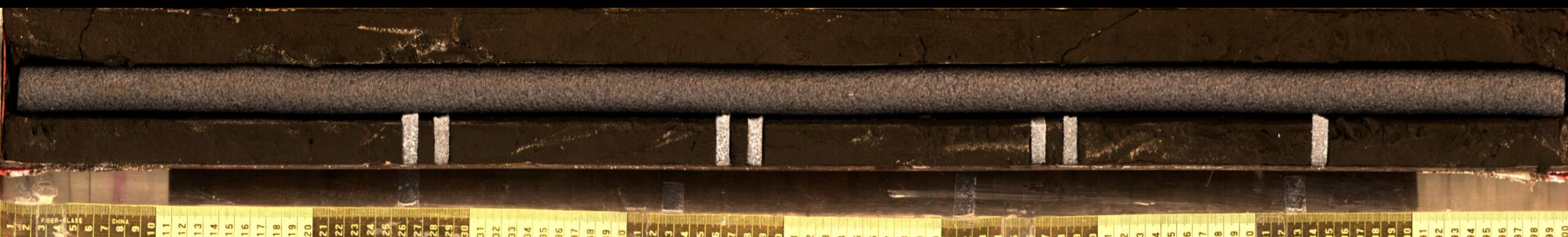
  Ex. p-mag > XRF > CNS,d13C,bSi
- Curate remaining core
- Foam voids

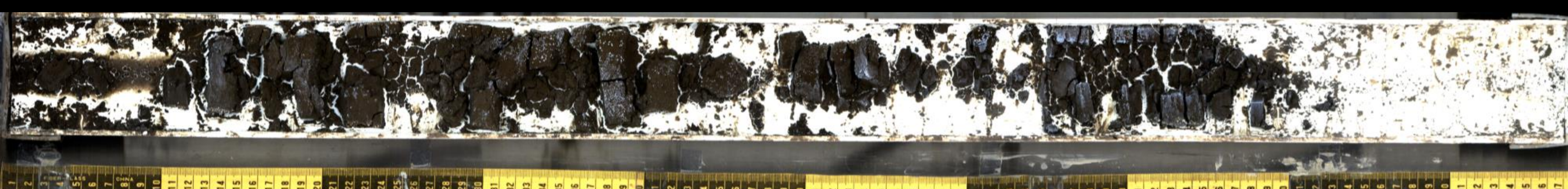




Stabilize sample voids

Backer rod (closed-cell PE foam)



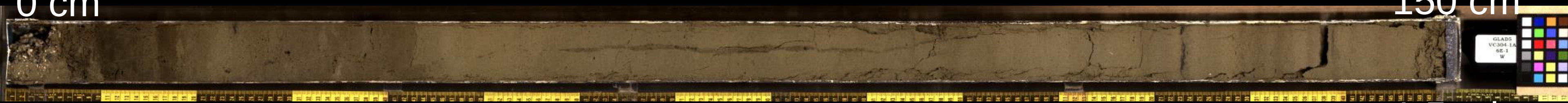


Depths

Below section top

Database translates using section ID and metadata

0 cm 150 cm



0 mbs 1.5 mbs

0 cm 150 cm

7 mbs 8.5 mbs

0 cm 150 cm

151.4 mbs 152.9 mbs

Data Management

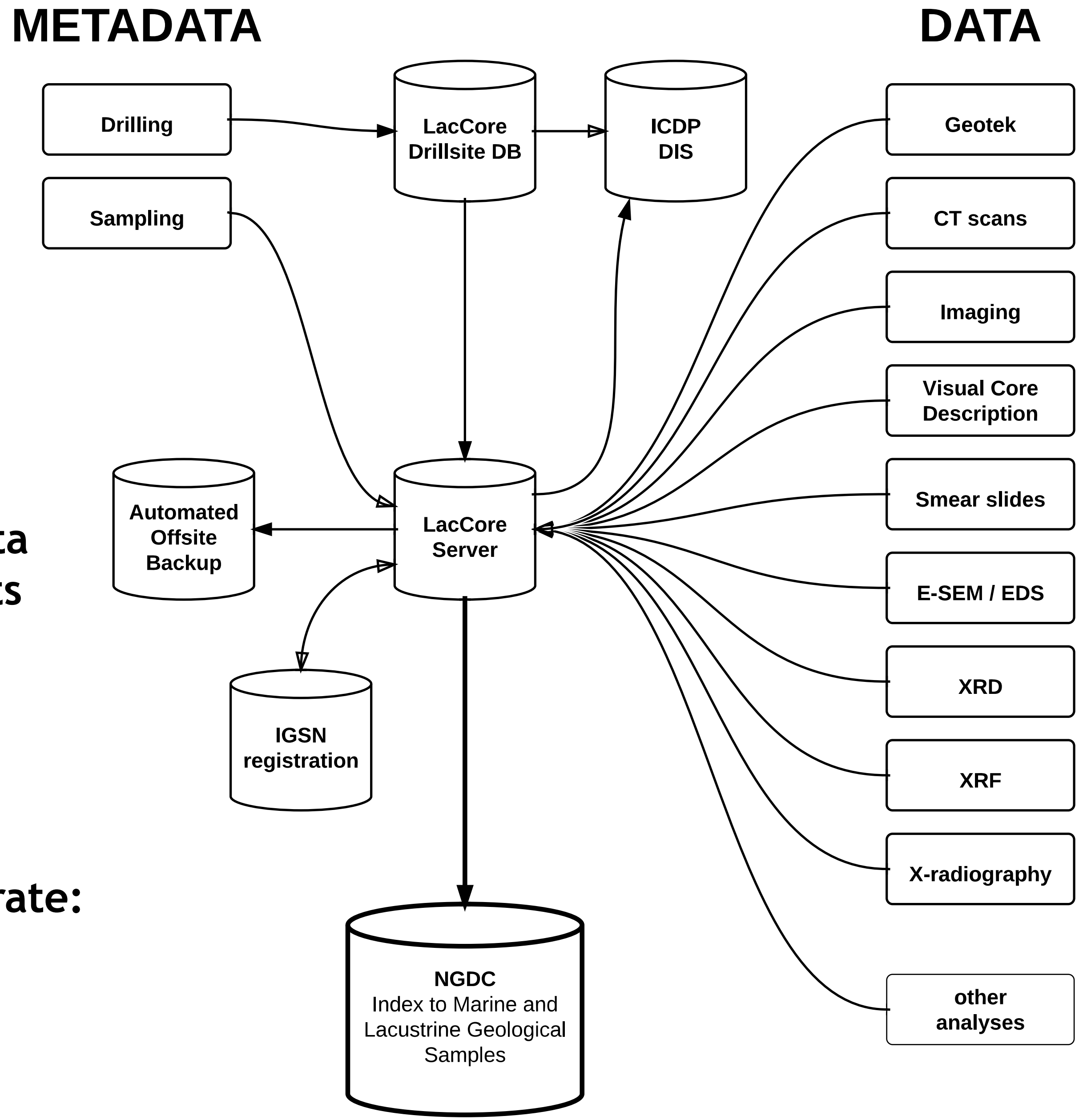
- Efficient
- Interoperable
- Secure
- Available
- Permanent

Fulfills funding agency data management requirements for:

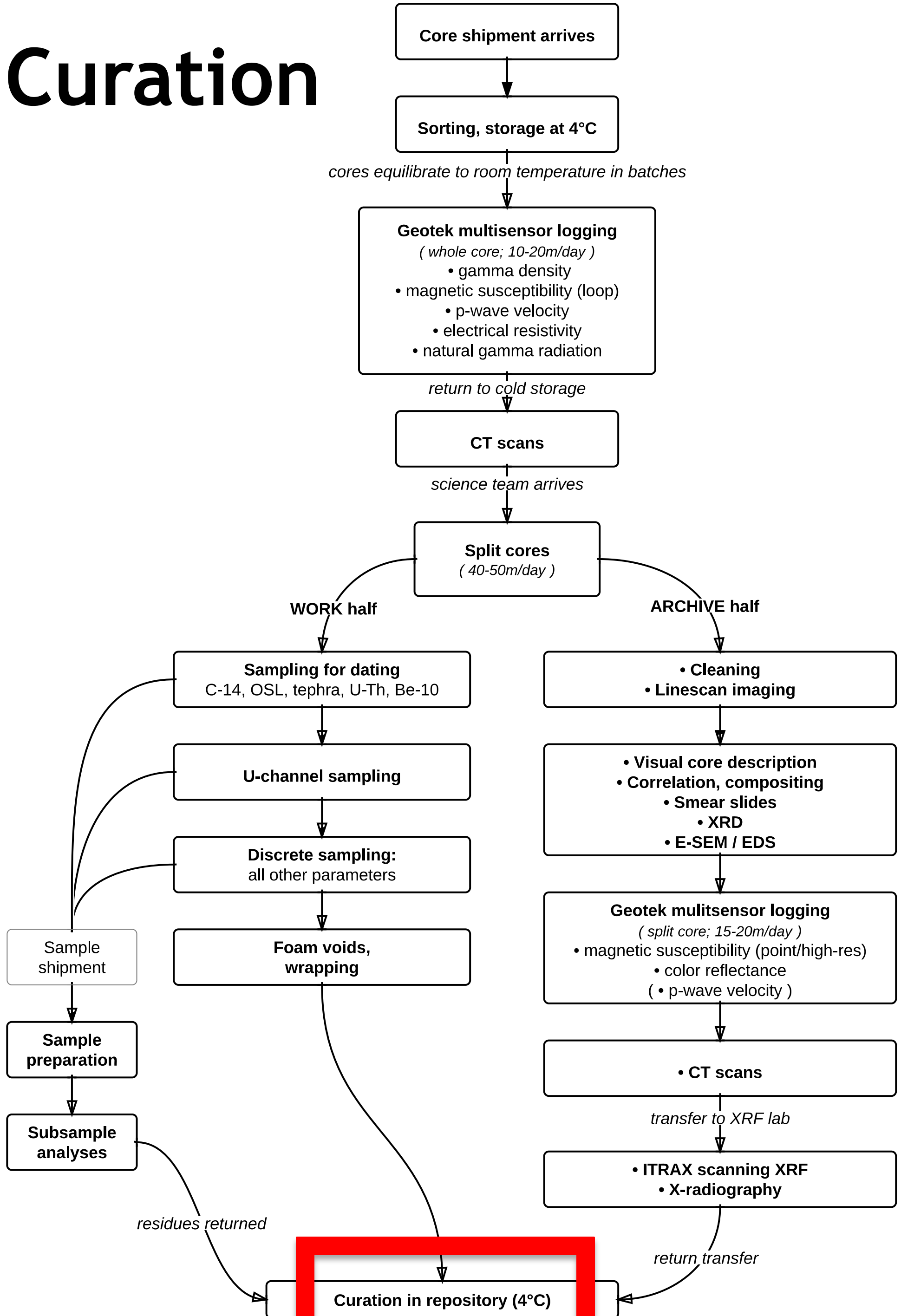
- metadata
- physical samples
- fundamental datasets

Publication datasets separate:

- NCDC
- PANGAEA



Curation


Core shipment arrives
Sorting, storage at 4°C
cores equilibrate to room temperature in batches
Geotek multisensor logging
(whole core; 10-20m/day)
• gamma density
• magnetic susceptibility (loop)
• p-wave velocity
• electrical resistivity
• natural gamma radiation
return to cold storage
CT scans
science team arrives
Split cores
(40-50m/day)
WORK half
ARCHIVE half
Sampling for dating
C-14, OSL, tephra, U-Th, Be-10
U-channel sampling
Discrete sampling:
all other parameters
Foam voids,
wrapping
Sample
shipment
Sample
preparation
Subsample
analyses
residues returned
• Cleaning
• Linescan imaging
• Visual core description
• Correlation, compositing
• Smear slides
• XRD
• E-SEM / EDS
Geotek mulitsensor logging
(split core; 15-20m/day)
• magnetic susceptibility (point/high-res)
• color reflectance
(• p-wave velocity)
• CT scans
transfer to XRF lab
• ITRAX scanning XRF
• X-radiography
return transfer
Curation in repository (4°C)

Supplies

Labels + printers + ribbons

Plastic film for wrapping cores (O_2, $H_2$0 barrier)

- PVDC / polyvinylidene chloride: Krehalon CB100 46-gauge
- LDPE (low-density polyethylene) films from food stores transmit water vapor and oxygen at rates 5x and 500x faster than PVDC

Plastic film (ultraclear), does not cling or wrinkle

- Polyester Melinex 462 200-gauge

D-tubes + caps

- Polystyrene, IODP tubes
- For physical protection only

U-channels

- Polystyrene—sediment dehydrates rapidly

Tape

- Polyethylene for u-channels
- PVC for Dtube endcaps

Coldroom and racks

- Temperature monitors / alarms: Prevent subfreezing temperatures

Labels

Attach metadata to the core

[SectionIDLacCore],OrigID,[SectionIDOriginal],IGSN,[SectionIGSN],Loc,[LocationName],Lat,[Latitude],Lon,[Longitude],Elev,[Elevation],WaterD,[WaterDepth],SedD,[SedimentDepthTop]-[SedimentDepthBottom],PI,[ScientistFirstInitial].[ScientistLastName]/[additional names separated by slashes if applicable];

Labels

Zebra ZM400 printer
Z-Ultimate 2000T thermal transfer labels
Zebra 5095 resin ribbon

- Labels won't tear, scratch, dissolve
- Remain viable in subfreezing, wet, saline environments

Barcode: QR Code 2D

- Maximum possible number of alphanumeric characters
- Best readability on uneven / curved surfaces and with damaged codes

Curation

Sharing requirements: Data/Samples

> "For those programs in which selected principle investigators have initial periods of exclusive data use, data should be made openly available as soon as possible, but no later than two (2) years after the data were collected."

-- NSF Division of Earth Sciences Data Policy
http://www.nsf.gov/geo/ear/EAR_data_policy_204.pdf

Data Discovery

Curation

Sample Requests

Is the analysis experimental?

- Test with a preliminary set of samples

What is the minimum sample volume / mass?

- How is this assessed?

Avoid depleting entire intervals

Preserve sediment in the core as long as possible

- Provide stratigraphic context for new samples

Take the long view


Take the long view