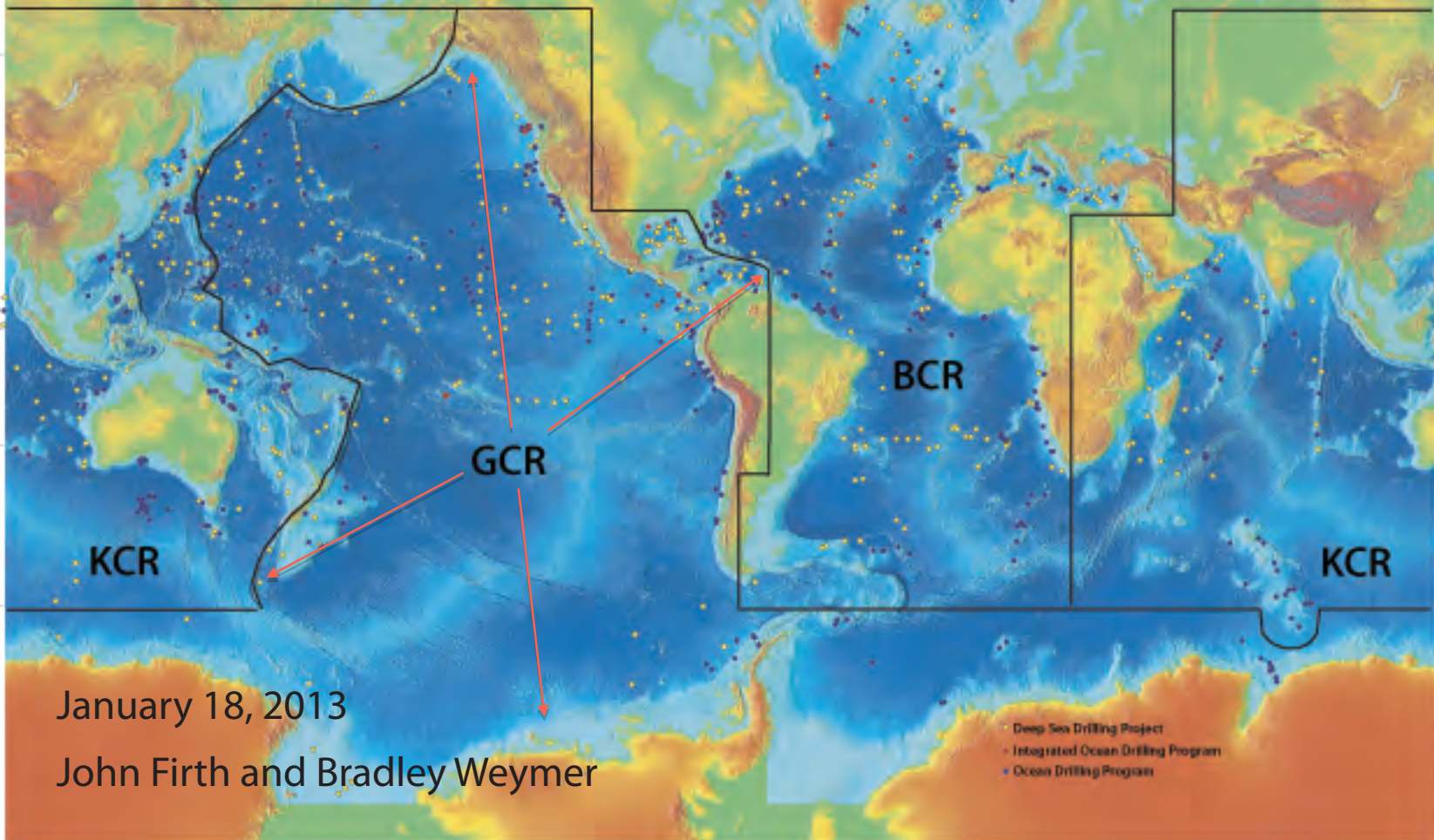
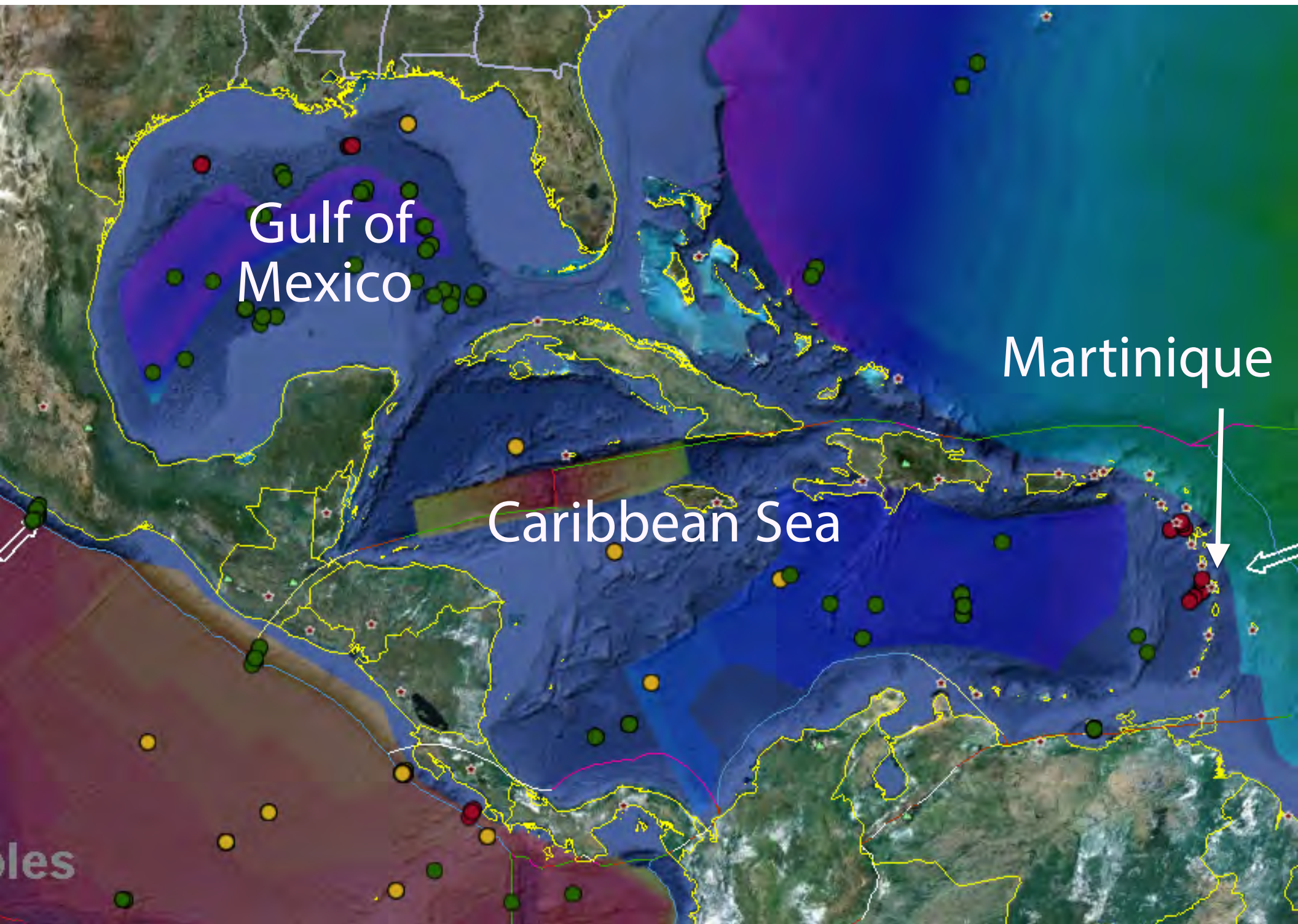


# "The GCR Collection: from Alaska to Antarctica and from Martinique to Macquarie Ridge"



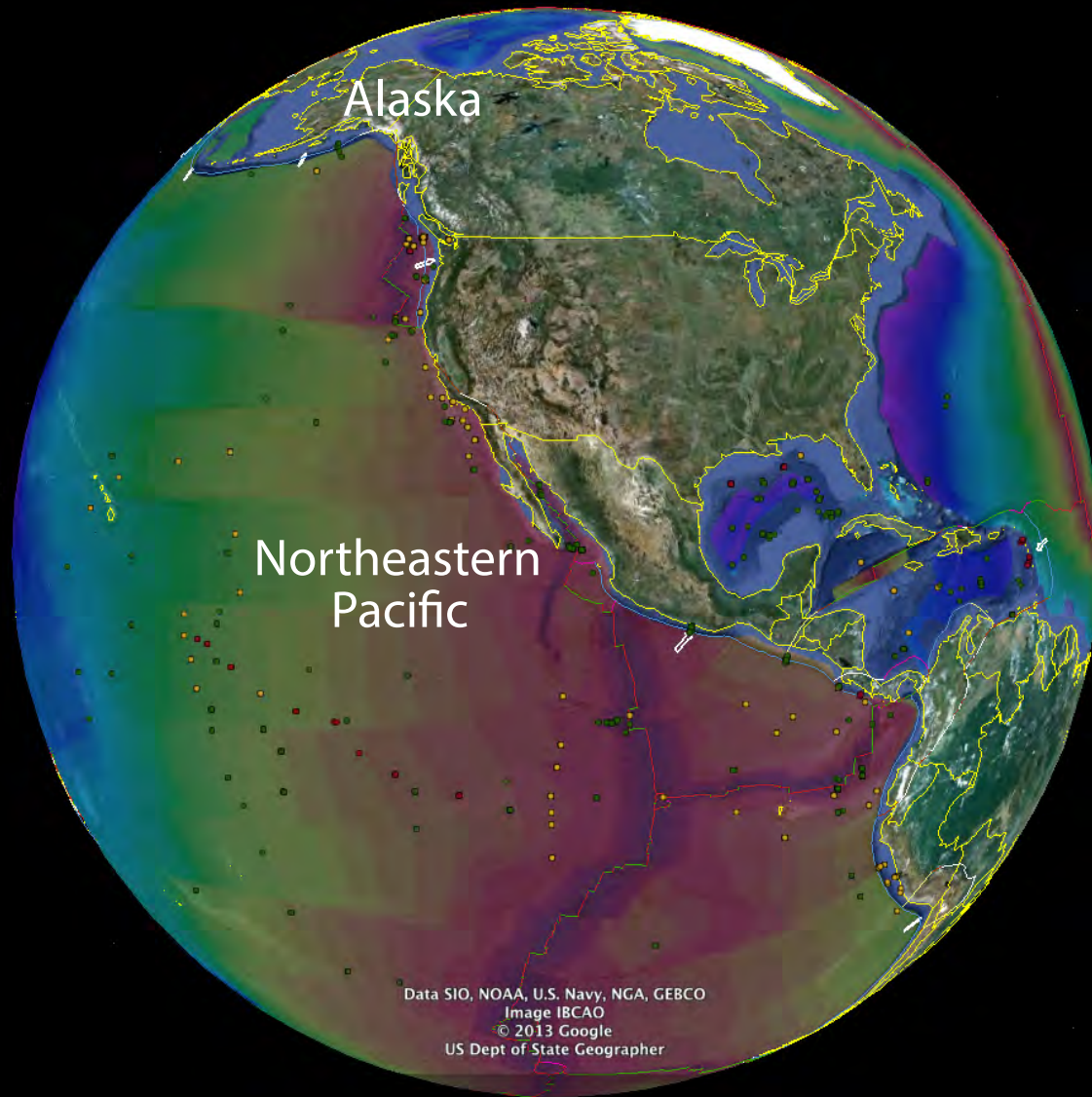
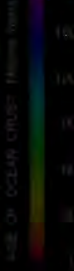


Gulf of Mexico

Martinique

Caribbean Sea

les



**Drilled holes**

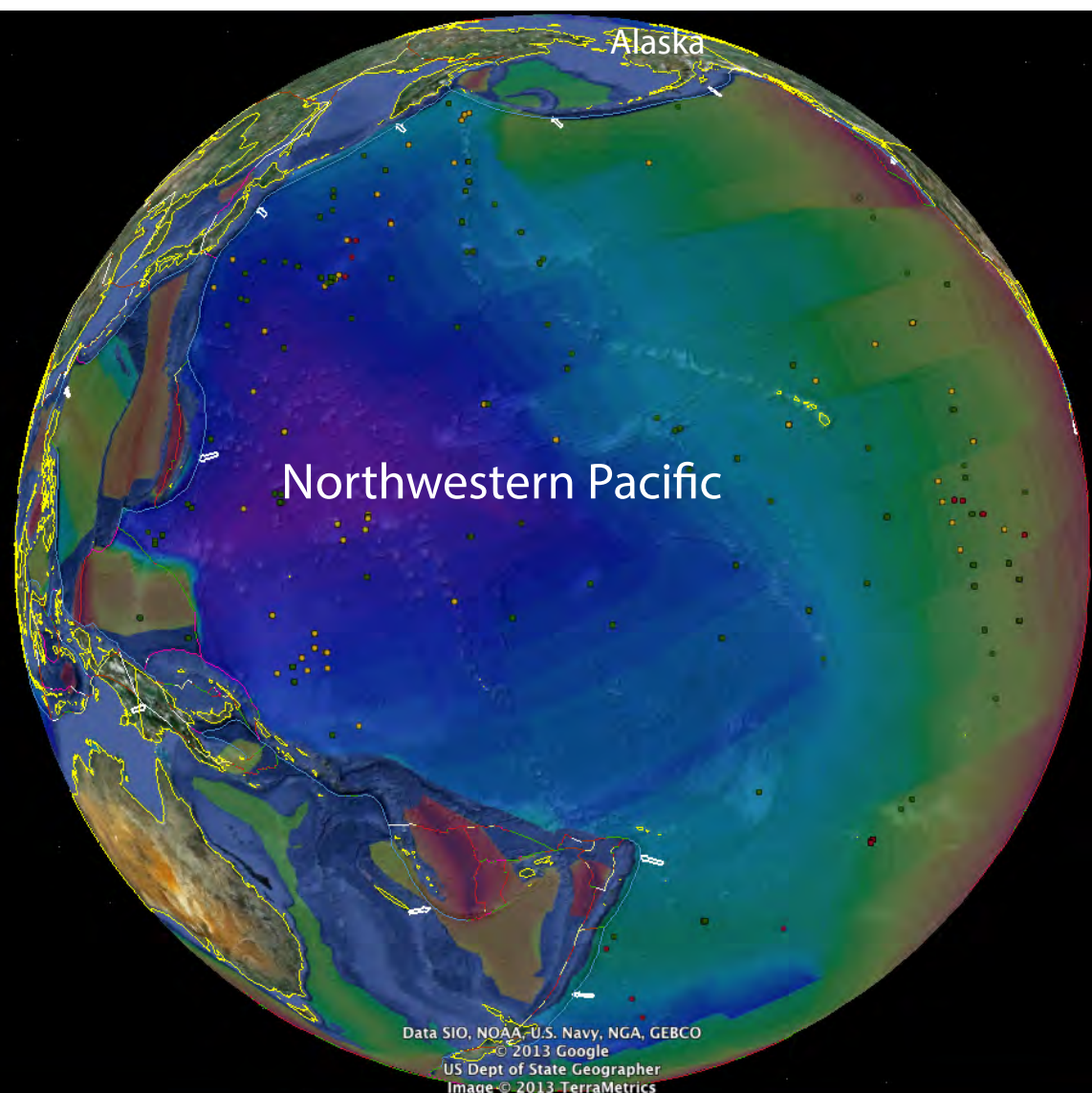
- IODP
- ODP
- DSDP

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image IBCAO  
© 2013 Google  
US Dept of State Geographer



Google earth

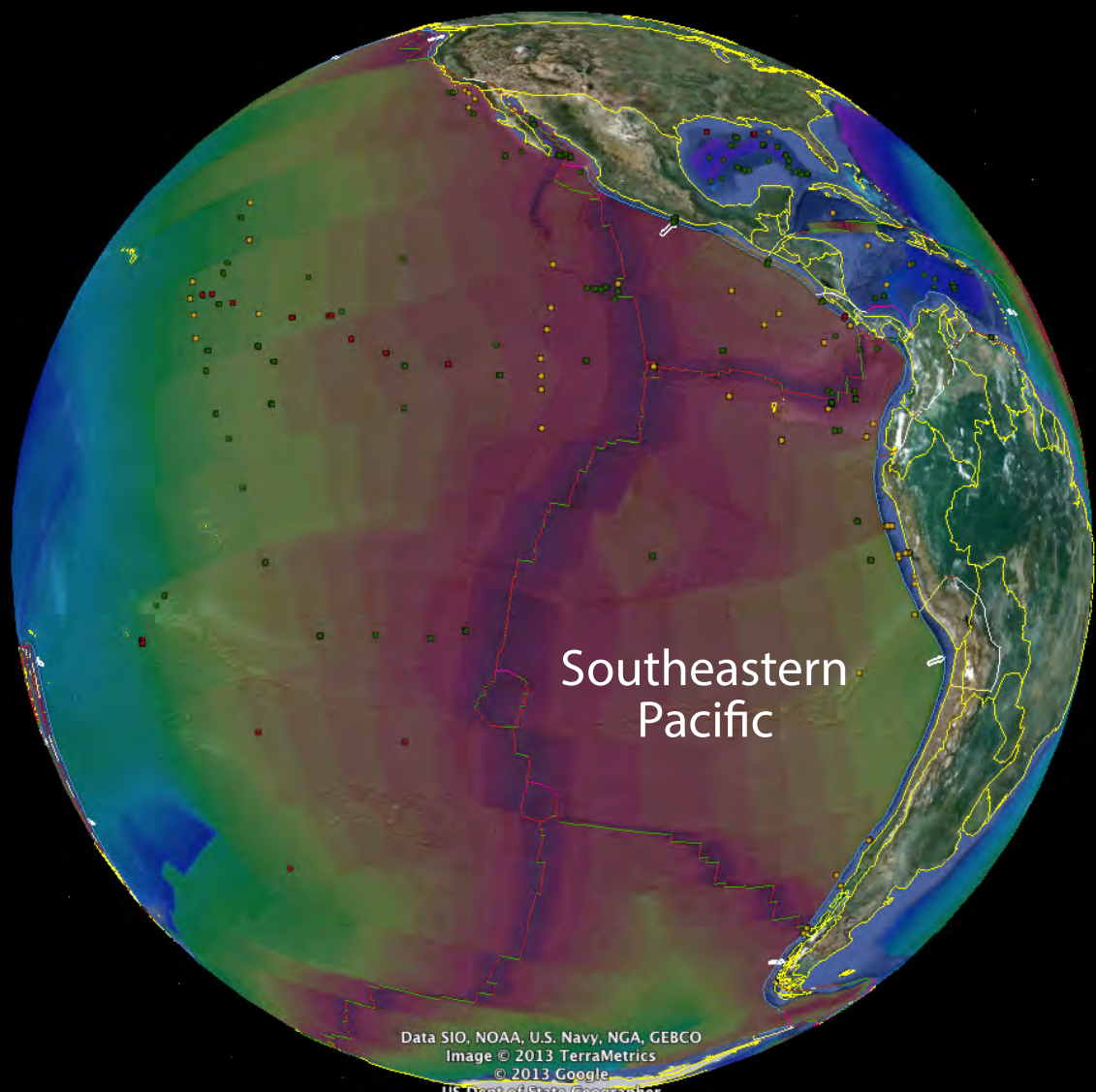
Eye alt 9607.13 mi



- Drilled holes**
- IODP
  - ODP
  - DSDP

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
© 2013 Google  
US Dept of State Geographer  
Image © 2013 TerraMetrics

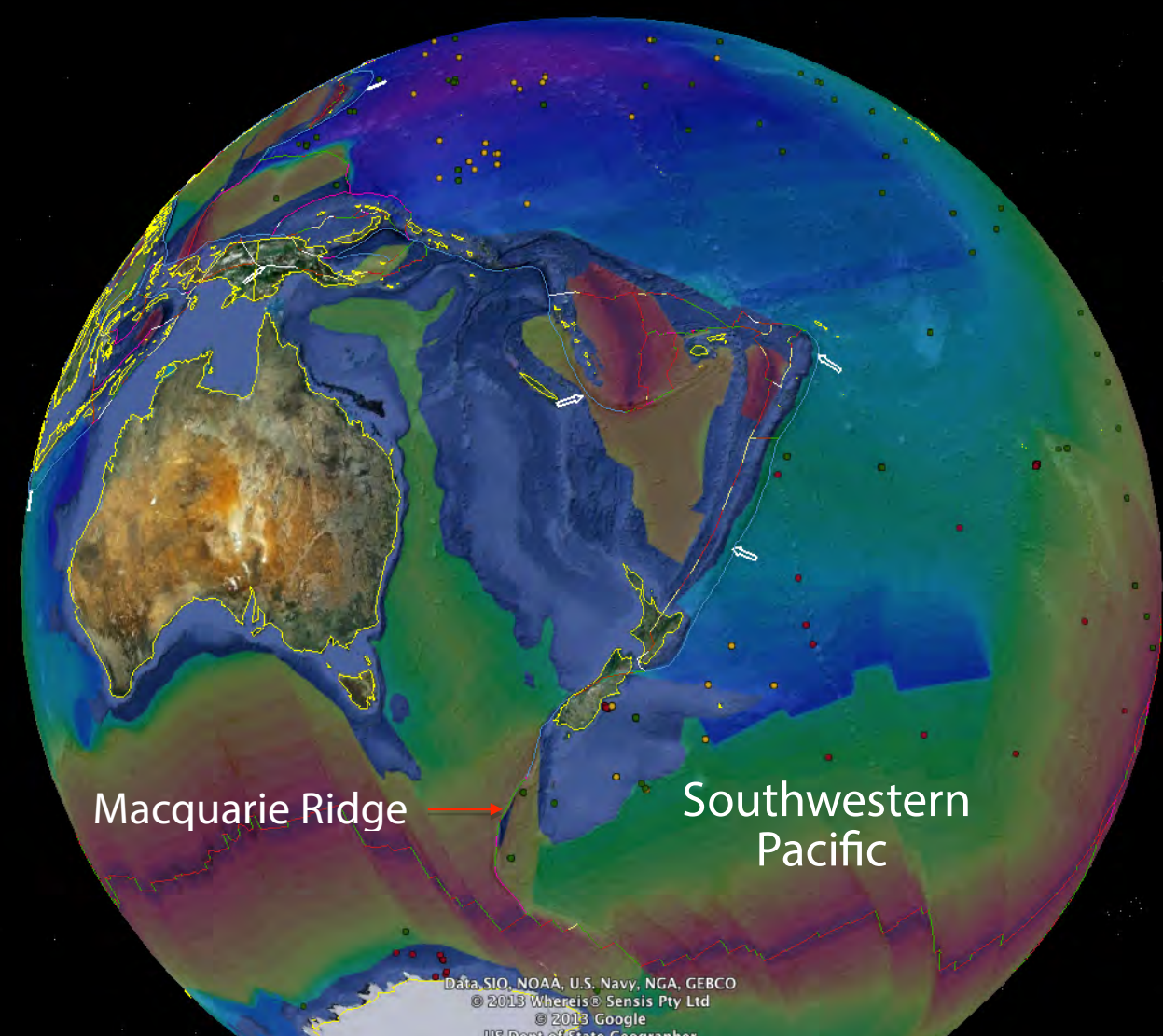
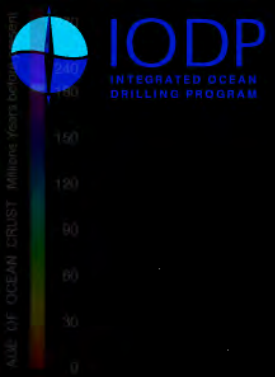
Google earth



- Drilled holes**
- IODP
  - ODP
  - DSDP

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2013 TerraMetrics  
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Google earth

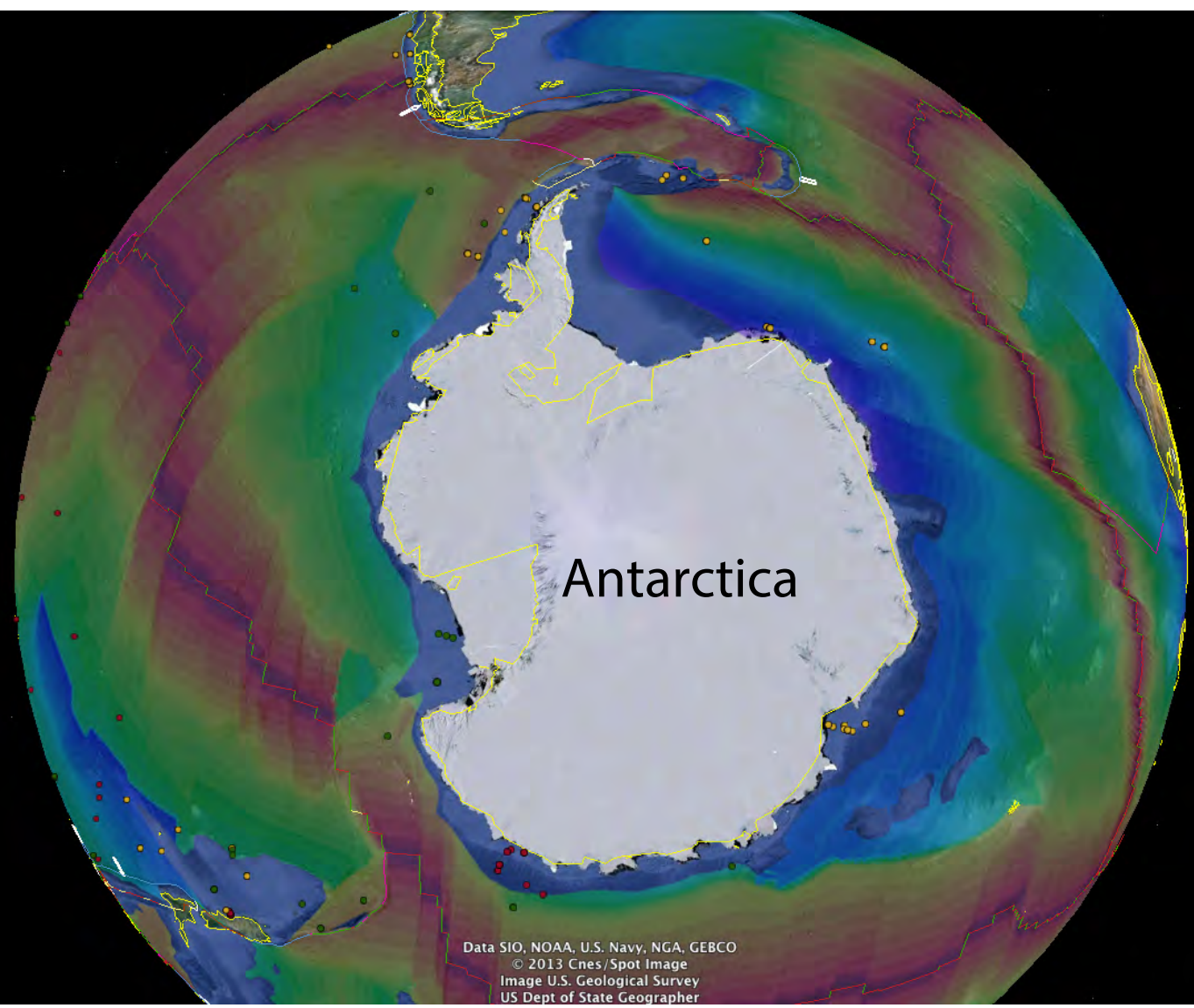
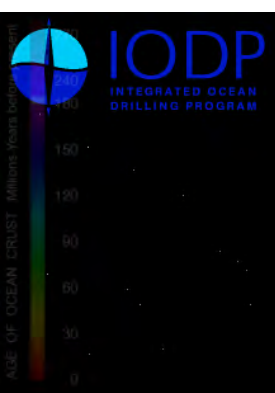


- Drilled holes**
- IODP
  - ODP
  - DSDP

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
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Google earth





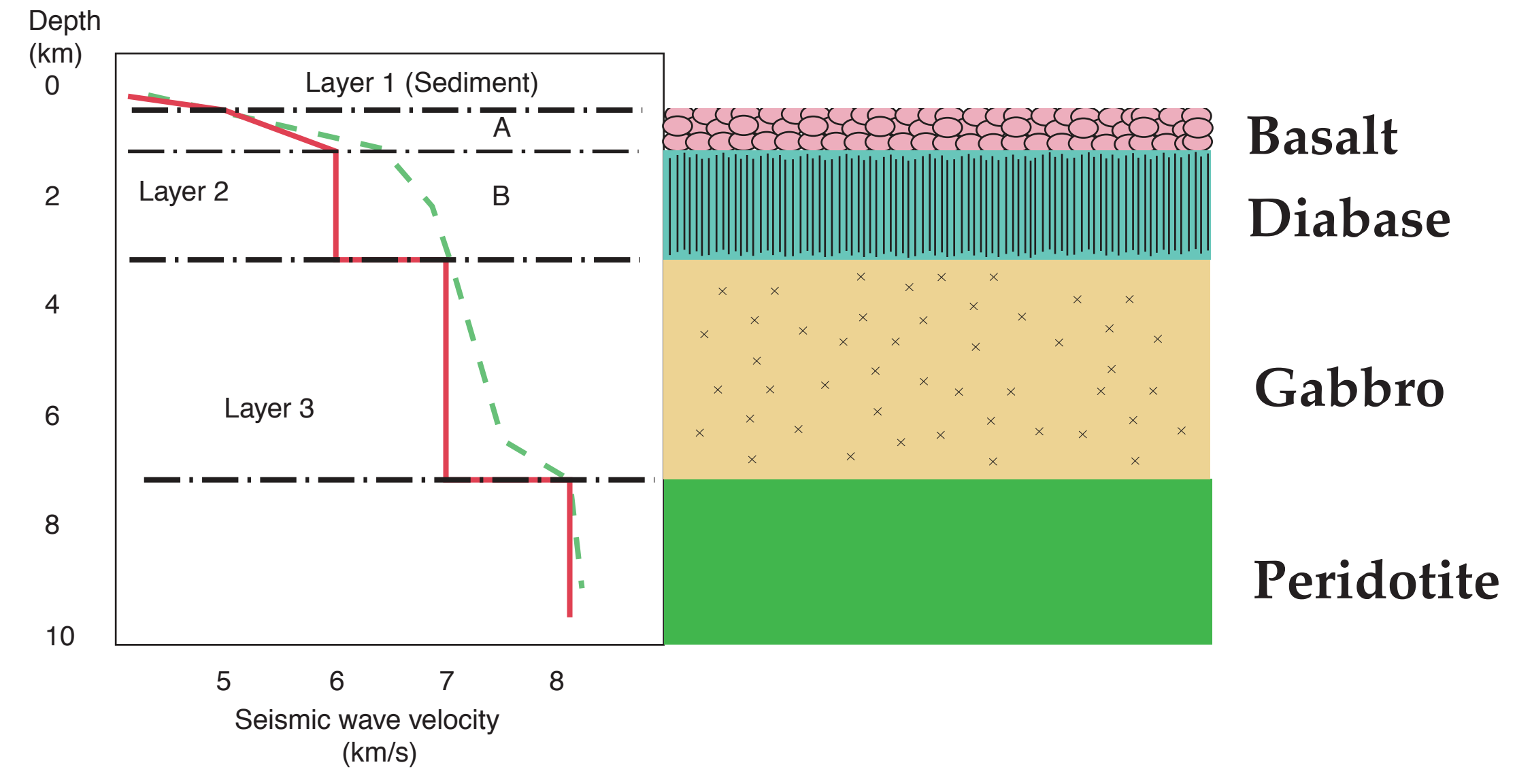
- Drilled holes**
- IODP
  - ODP
  - DSDP

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
© 2013 Cnes/Spot Image  
Image U.S. Geological Survey  
US Dept of State Geographer

Google earth

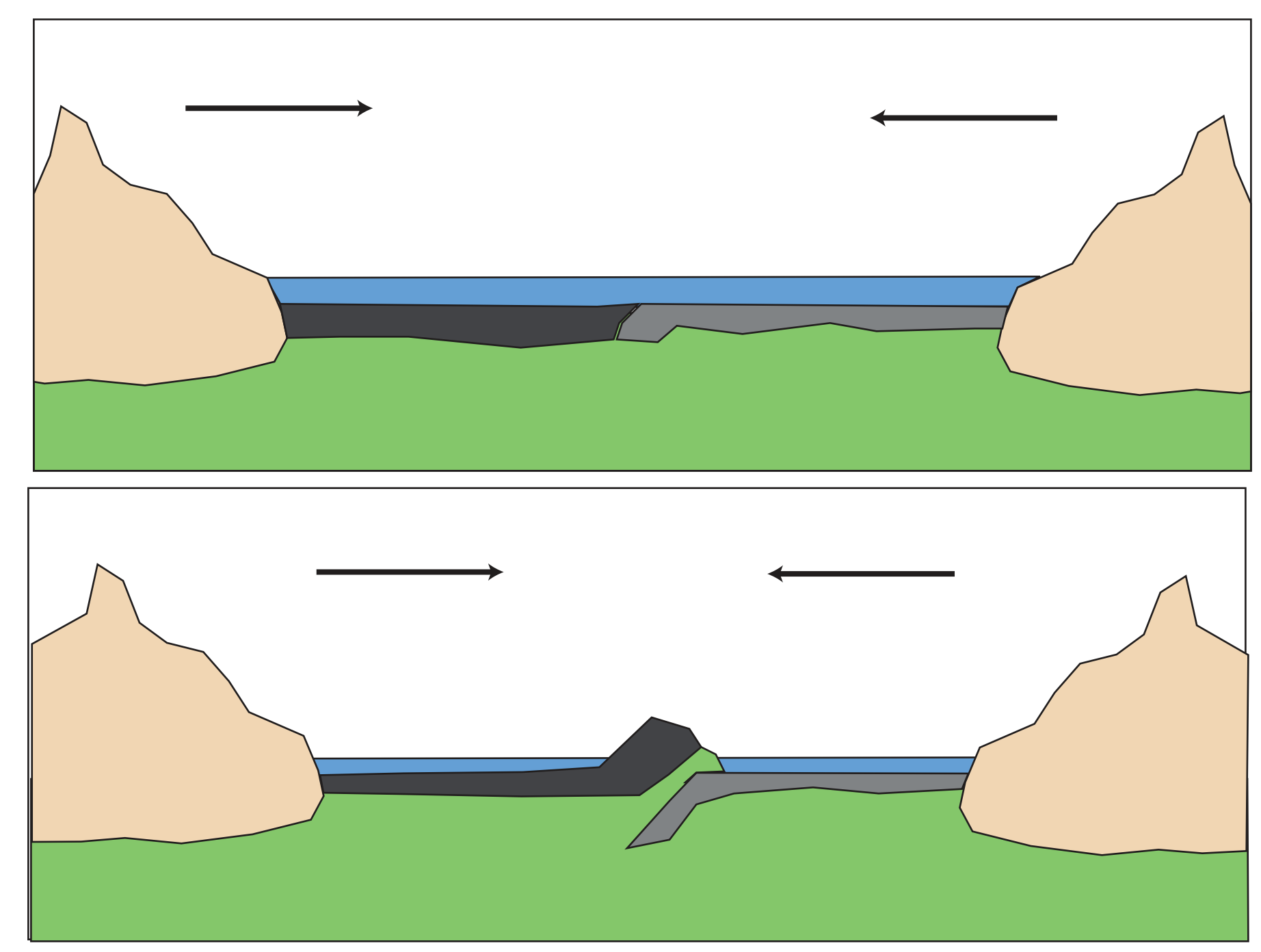
# Ophiolite Model of the Ocean Crust

Modified from Miller, 2001

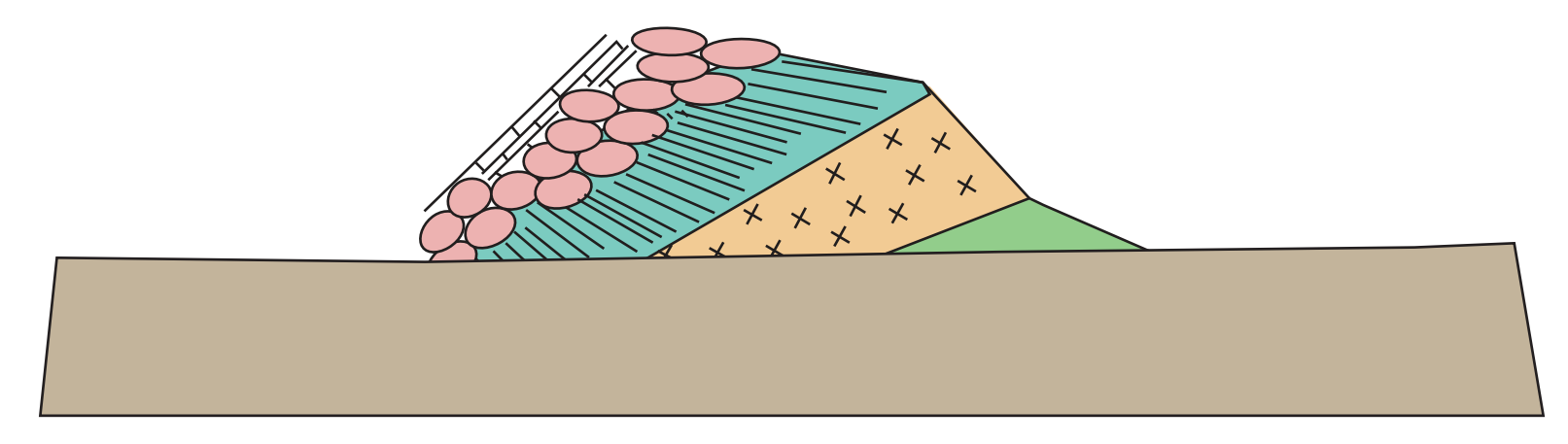


Seismic models suggest layered structure  
Properties of dredged lithologies match seismic profile

## Ophiolite formation



Two plates collide, one is subducted, the other obducted



Ophiolite section preserved



Troodos ophiolite, Cyprus  
Owing to the tectonic forces that exhum ophiolite sequences from the ocean floor and emplace them on land, reconstructing the complex stratigraphy can be a challenge.

### Basalt

### Basalt

LEG 206  
SITE 1256  
HOLE C  
CORE 6R

### Diabase

LEG 140  
SITE 504  
HOLE B  
CORE 200R

### Gabbro

LEG 312  
SITE 1256  
HOLE D  
CORE 214R

### Peridotite

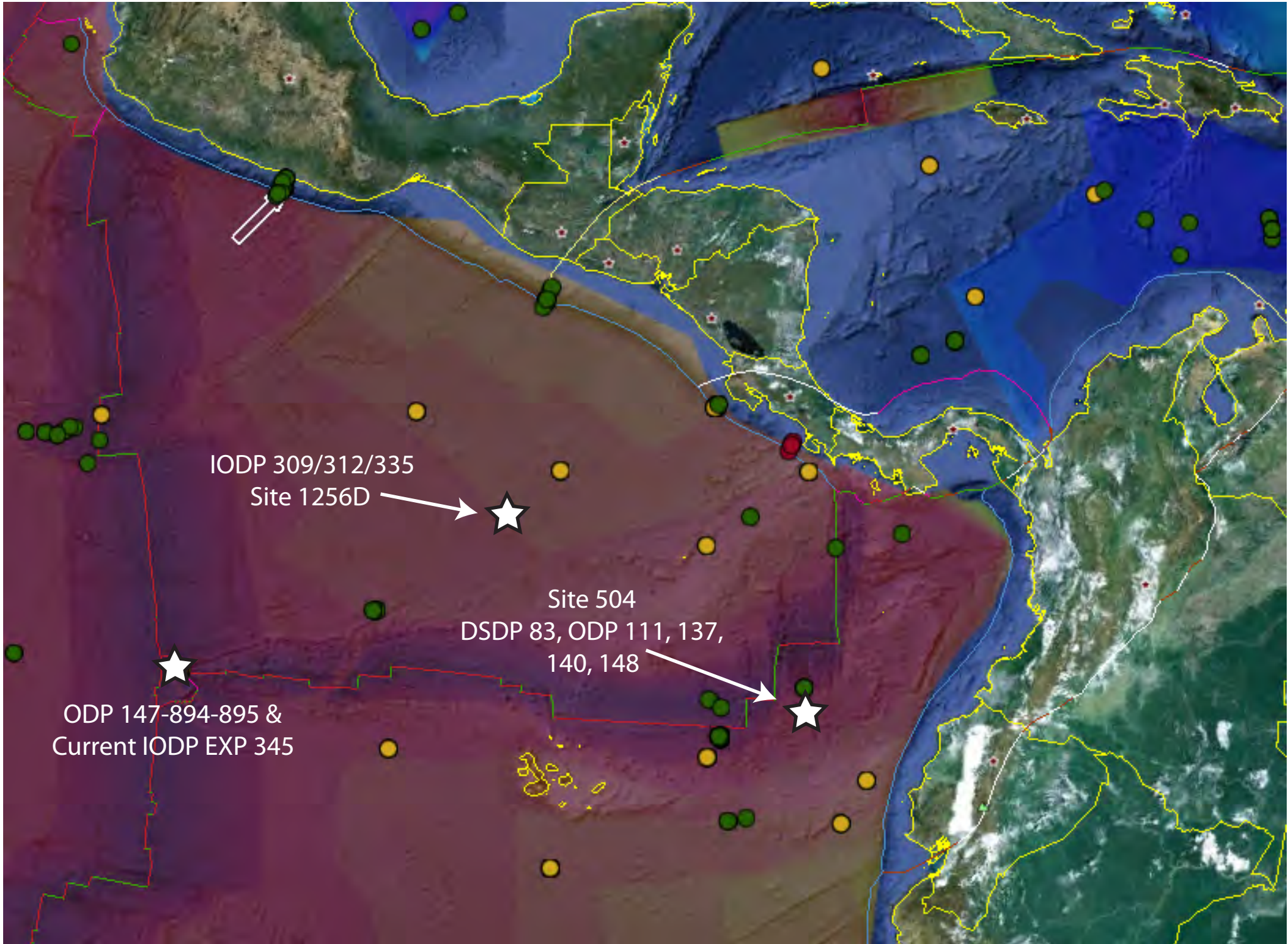
LEG 147  
SITE 895  
HOLE E  
CORE 6R



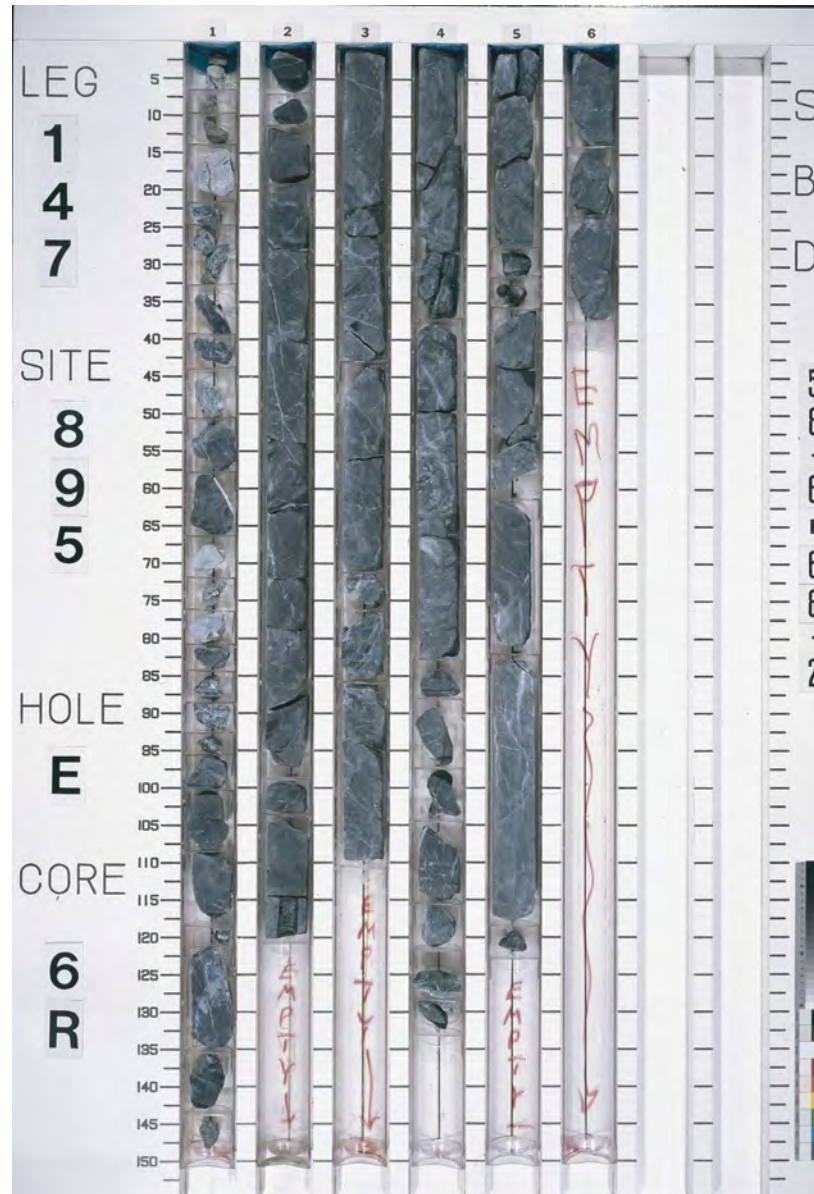
# Peridotite, Gabbro, and Diabase/Layer 2b Cores from DSDP, ODP, IODP at the GCR

| <b>Peridotites/Ultramafics</b> | <b>Sites</b>            | <b>Feature</b>                           |
|--------------------------------|-------------------------|--|
| <b>Leg/Expedition</b>          |                         |  |
| <b>147</b>                     | <b>895</b>              | <b>East Pacific Rise, Hess Deep Rift</b> |
|                                |                         |  |
| <b>Gabbros/Plutonics</b>       | <b>Sites</b>            | <b>Feature</b>                           |
| <b>Leg/Expedition</b>          |                         |  |
| <b>147</b>                     | <b>894</b>              | <b>East Pacific Rise, Hess Deep Rift</b> |
|                                | <b>895</b>              | <b>East Pacific Rise, Hess Deep Rift</b> |
| <b>312</b>                     | <b>1256</b>             | <b>Cocos Plate</b>                       |
| <b>335</b>                     | <b>1256</b>             | <b>Cocos Plate</b>                       |
|                                |                         |  |
| <b>Diabase/Sheeted Dikes</b>   | <b>Sites</b>            | <b>Feature</b>                           |
| <b>Leg/Expedition</b>          |                         |  |
| <b>83</b>                      | <b>504</b>              | <b>Costa Rica Rift</b>                   |
| <b>111</b>                     | <b>504</b>              | <b>Costa Rica Rift</b>                   |
| <b>137</b>                     | <b>504</b>              | <b>Costa Rica Rift</b>                   |
| <b>140</b>                     | <b>504</b>              | <b>Costa Rica Rift</b>                   |
| <b>148</b>                     | <b>504</b>              | <b>Costa Rica Rift</b>                   |
| <b>309</b>                     | <b>1256</b>             | <b>Cocos Plate</b>                       |
| <b>312</b>                     | <b>1256</b>             | <b>Cocos Plate</b>                       |
| <b>345</b>                     | <b>Currently coring</b> | <b>East Pacific Rise, Hess Deep Rift</b> |

# Peridotite, Gabbro, and Diabase/Layer 2b Cores from DSDP, ODP, IODP at the GCR



# MANTLE



Mostly Dunite

# GABBRO

312-1256D-214R-1 (Section top: 1410.9 mbsf)

LEG

3  
1  
2

SITE

1  
2  
5  
6

HOLE

D

CORE

2  
1  
4  
R



Plutonic Rock

UNIT: 81

ROCK NAME: Medium-grained oxide gabbro

SUMMARY DESCRIPTION: Medium-grained oxide gabbro

TEXTURE: Ineqgranular-seriate

PIECES: 1-8 and part of 9

COLOR: Dark bluish grey (SB 4/1)

CONTACTS: Upper: intrusive margins in Piece 13 of Core 213R-1; Lower: intrusive margin in Piece 9 of Core 214R-1

UNIT: 82

ROCK NAME: Medium-grained quartz-rich oxide diorite

SUMMARY DESCRIPTION: Medium-grained quartz-rich oxide diorite

TEXTURE: Ineqgranular-seriate

PIECES: Part of 9, all of 10-14, parts of 15 and 16, all of 21-25, parts of 26-28

COLOR: Grey (N6)

CONTACTS: Upper: intrusive margins in Piece 9 of Core 213R-1; Lower: intrusive margin with Unit 84 in Piece 25 of Core 214R-1

UNIT: 83

ROCK NAME: Medium-grained disseminated oxide gabbro

SUMMARY DESCRIPTION: Medium-grained disseminated oxide gabbro

TEXTURE: Seriate

PIECES: 7-20

COLOR: Bluish grey (SB 6/1)

CONTACTS:

Upper: not recovered

Lower: not recovered

UNIT: 84

ROCK NAME: Medium-grained disseminated oxide gabbro

SUMMARY DESCRIPTION: Medium-grained disseminated oxide gabbro

TEXTURE: Ineqgranular-seriate

PIECES: Parts of 26-28

COLOR: Bluish grey (SB 5/1)

CONTACTS: Upper: intrusive margin with Unit 82 in Piece 26; Lower: not recovered

312-1256D-214R-2 (Section top: 1412.35 mbsf)

Plutonic Rock

UNIT: 84

ROCK NAME: Medium-grained disseminated oxide gabbro

SUMMARY DESCRIPTION: Medium-grained disseminated oxide gabbro

TEXTURE: Seriate

PIECES: 1-6

COLOR: Bluish grey (SB 5/1)

CONTACTS:

Upper: intruded by Unit 82 in Piece 26 of Section 214R-1

Lower: not recovered

UNIT: 85

ROCK NAME: Medium-grained disseminated oxide gabbro

SUMMARY DESCRIPTION: Medium-grained disseminated oxide gabbro

TEXTURE: Seriate

PIECES: 7-20

COLOR: Bluish grey (SB 6/1)

CONTACTS:

Upper: not recovered

Lower: not recovered

312-1256D-214R-3 (Section top: 1413.81 mbsf)

Plutonic Rock

UNIT: 85

ROCK NAME: Medium-grained disseminated oxide gabbro

SUMMARY DESCRIPTION: Medium-grained disseminated oxide gabbro

TEXTURE: Seriate

PIECES: 1-5

COLOR: Bluish grey (SB 6/1)

CONTACTS:

Upper: not recovered

Lower: not recovered

# Layer 2b (Sheeted Dike) - Layer 3 (Gabbro) Transition

**Exp  
312**

**Hole  
1256D**

**Core  
213R**



## Volcanic Rock

**UNIT:** 80A

**ROCK NAME:** Aphyric microcrystalline to cryptocrystalline basalt

**SUMMARY DESCRIPTION:** Aphyric microcrystalline to cryptocrystalline basalt

**PIECES:** 1–11, parts of 12–13

### CONTACTS:

Upper: not recovered

Lower: apparent igneous contact in Piece 13

## Plutonic Rock

**UNIT:** 81

**ROCK NAME:** Medium-grained oxide gabbro

**SUMMARY DESCRIPTION:** Medium-grained oxide gabbro

**TEXTURE:** Equigranular

**PIECES:** Parts of 12 and 13

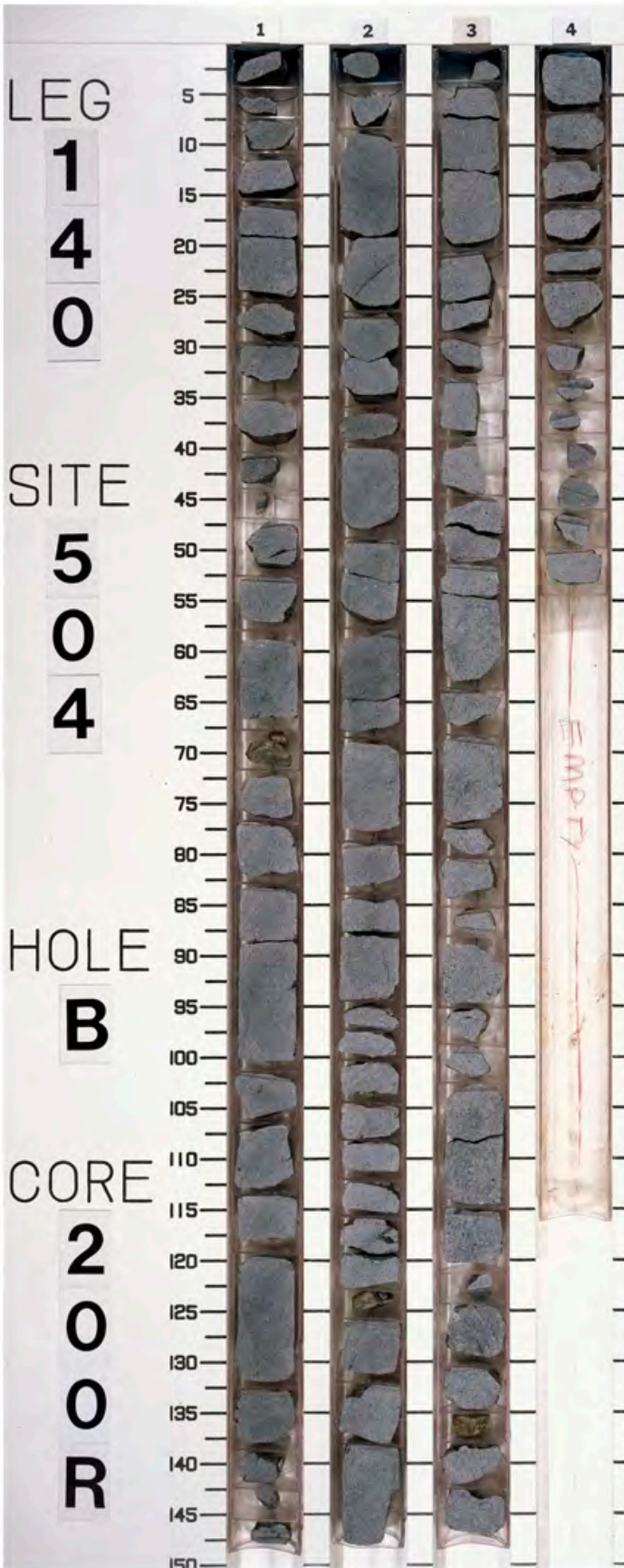
**COLOR:** Dark bluish grey (5B 4/1)

### CONTACTS:

Upper: intrusive margins in Piece 13

Lower: not recovered

# DIABASE



## Tectonically Deformed Sediments and Rocks in the GCR Collection

Shipboard Scientific Party, 1981. Introduction: Scientific Objectives and Explanatory Notes. In: Watkins, J.S., Moore, J.C., et al., Initial Reports DSDP, 66: Washington (U.S. Govt. Printing Office).

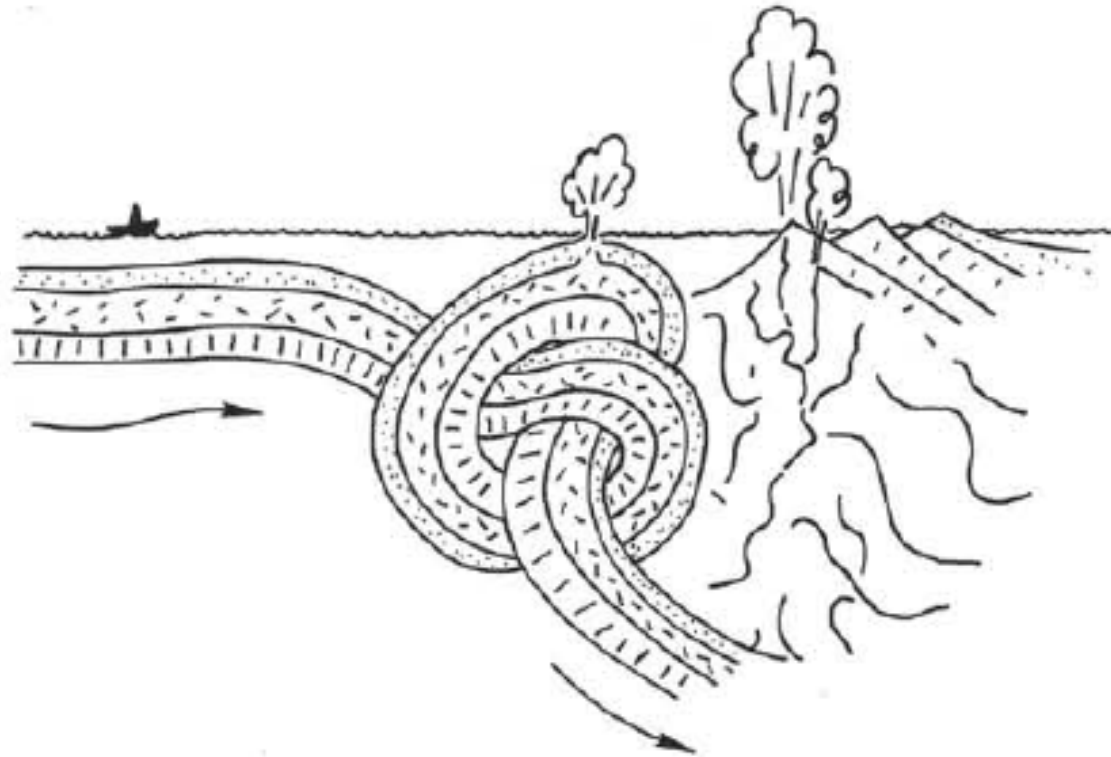


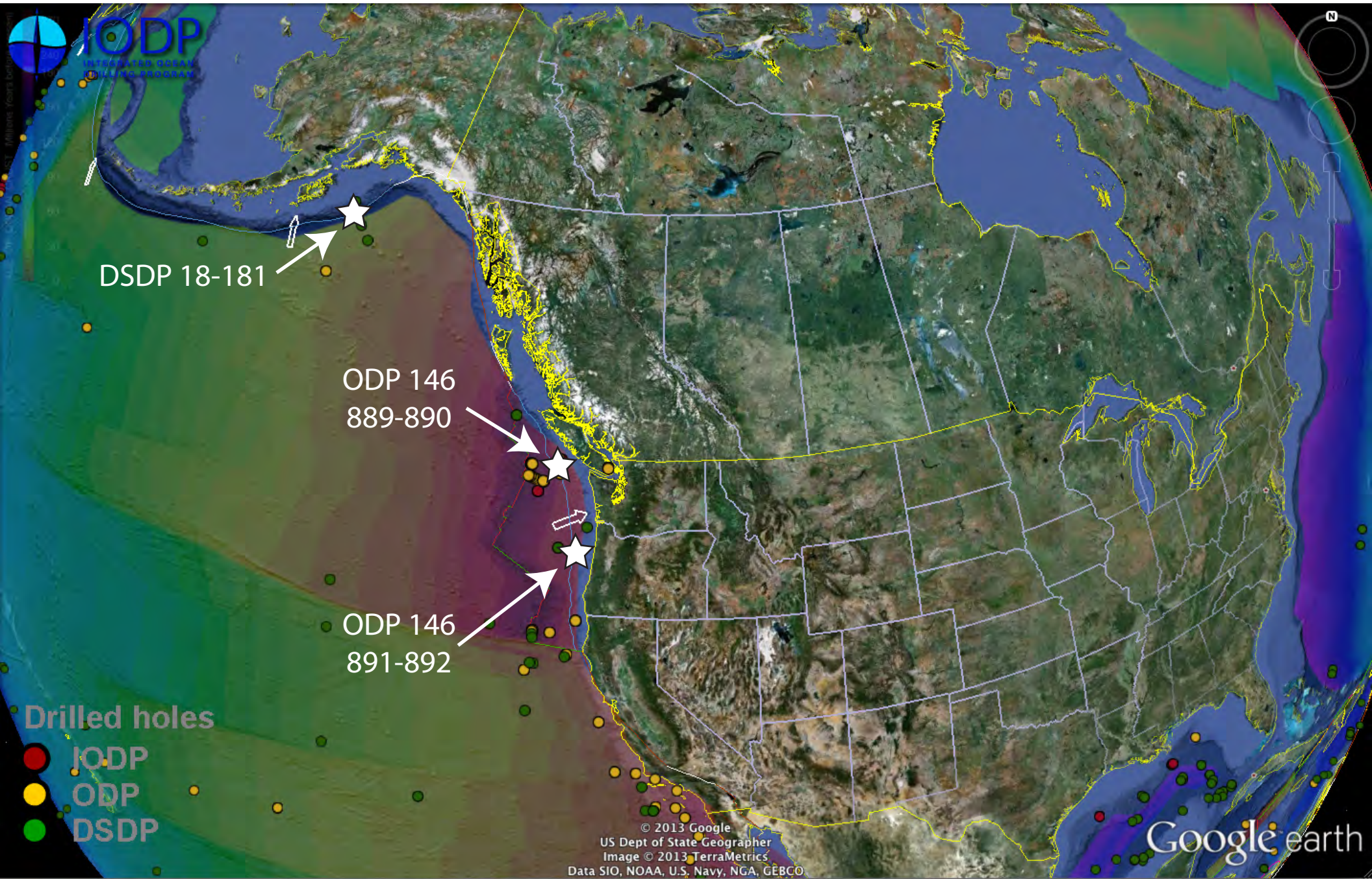
Figure 1. The complexity of active margins may not as yet be fully appreciated by earth scientists.

## Tectonically Deformed Sediments and Rocks in the GCR

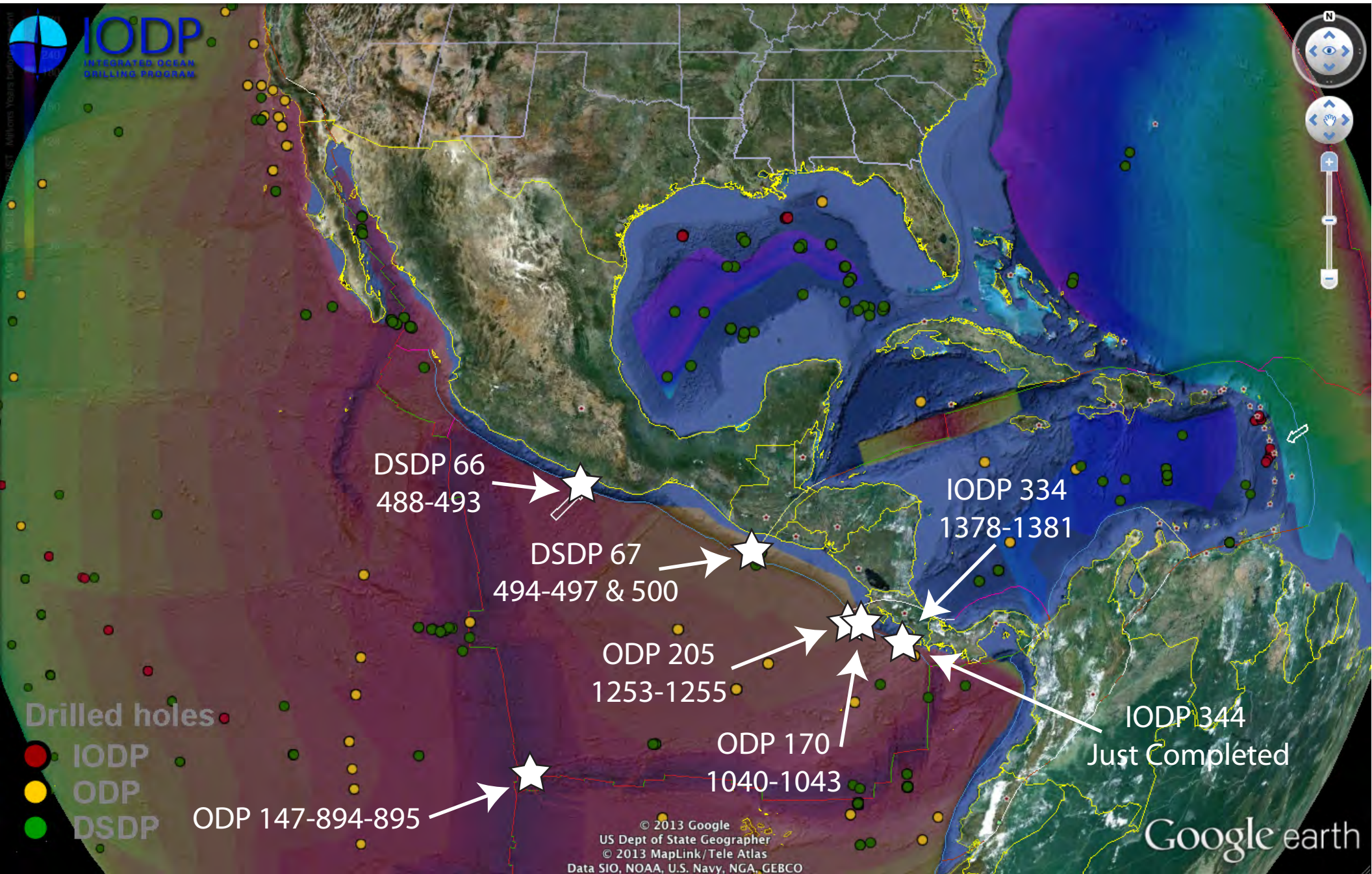
| Leg | Site                  | Region/Feature  |
|-----|-----------------------|---|
| 18  | 181                   | Aleutian Trench   |
| 66  | 488                   | Middle America Trench, southern Mexico                      |
|     | 489                   | Middle America Trench, southern Mexico                      |
|     | 490                   | Middle America Trench, southern Mexico                      |
|     | 491                   | Middle America Trench, southern Mexico                      |
|     | 492                   | Middle America Trench, southern Mexico                      |
|     | 493                   | Middle America Trench, southern Mexico                      |
| 67  | 494                   | Middle America Trench, Guatemala Transect                   |
|     | 495                   | Middle America Trench, Guatemala Transect                   |
|     | 496                   | Middle America Trench, Guatemala Transect                   |
|     | 497                   | Middle America Trench, Guatemala Transect                   |
|     | 500                   | Middle America Trench, Guatemala Transect                   |
| 141 | 859                   | Chile Triple Junction                                       |
|     | 860                   | Chile Triple Junction                                       |
|     | 861                   | Chile Triple Junction                                       |
|     | 862                   | Chile Triple Junction                                       |
|     | 863                   | Chile Triple Junction                                       |
| 146 | 889                   | Cascadia Accretionary Margin                                |
|     | 890                   | Cascadia Accretionary Margin                                |
|     | 891                   | Oregon Accretionary Margin                                  |
|     | 892                   | Oregon Accretionary Margin                                  |
| 147 | 894                   | Hess Deep Rift  |
|     | 895                   | Hess Deep Rift  |
| 170 | 1040                  | Middle America Trench, Costa Rica/Nicoya Peninsula Transect |
|     | 1041                  | Middle America Trench, Costa Rica/Nicoya Peninsula Transect |
|     | 1042                  | Middle America Trench, Costa Rica/Nicoya Peninsula Transect |
|     | 1043                  | Middle America Trench, Costa Rica/Nicoya Peninsula Transect |
| 205 | 1253                  | Middle America Trench, Costa Rica/Nicoya Peninsula Transect |
|     | 1254                  | Middle America Trench, Costa Rica/Nicoya Peninsula Transect |
|     | 1255                  | Middle America Trench, Costa Rica/Nicoya Peninsula Transect |
| 334 | 1378                  | Middle America Trench, Costa Rica/Osa Peninsula Transect    |
|     | 1379                  | Middle America Trench, Costa Rica/Osa Peninsula Transect    |
|     | 1380                  | Middle America Trench, Costa Rica/Osa Peninsula Transect    |
|     | 1381                  | Middle America Trench, Costa Rica/Osa Peninsula Transect    |
| 344 | coring just completed | Middle America Trench, Costa Rica/Osa Peninsula Transect    |



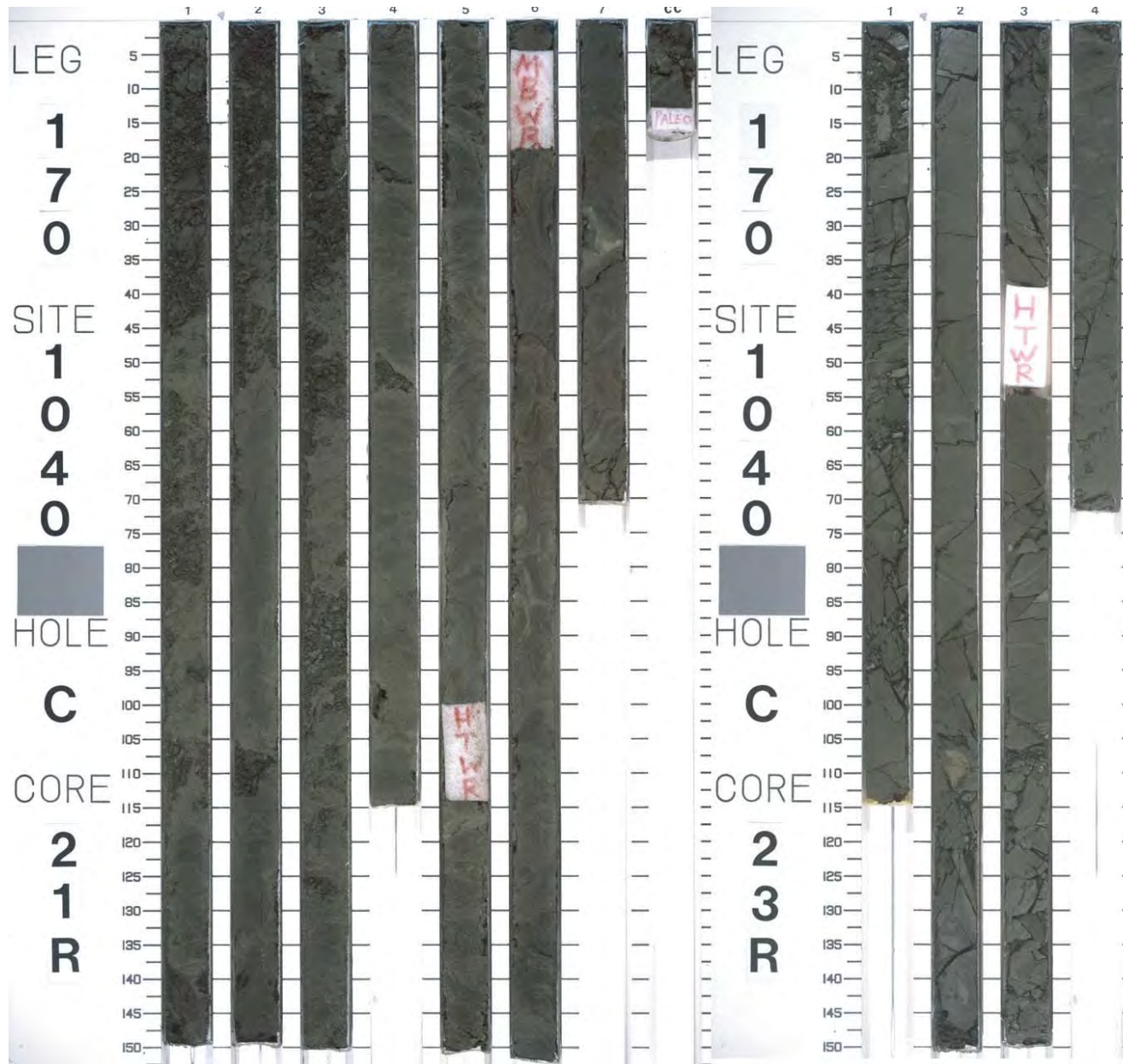
# Tectonically Deformed Sediments and Rocks in the GCR



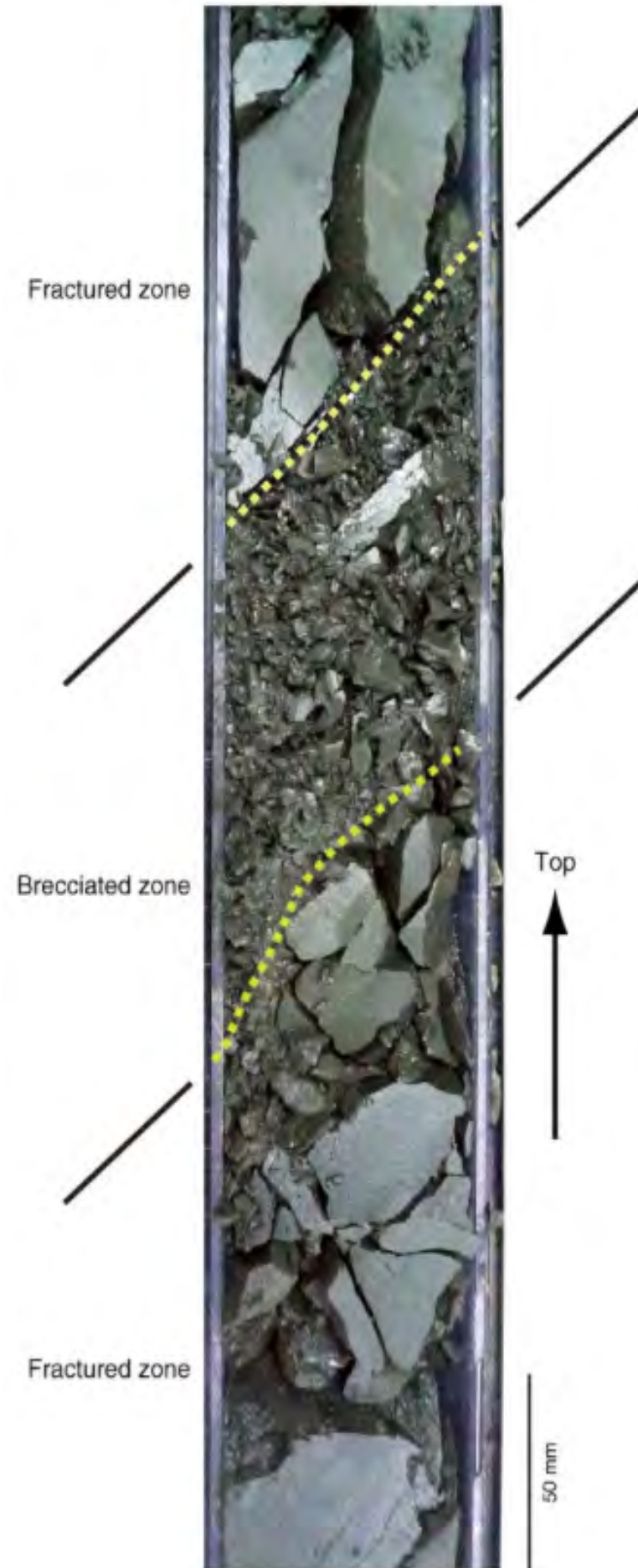
# Tectonically Deformed Sediments and Rocks in the GCR



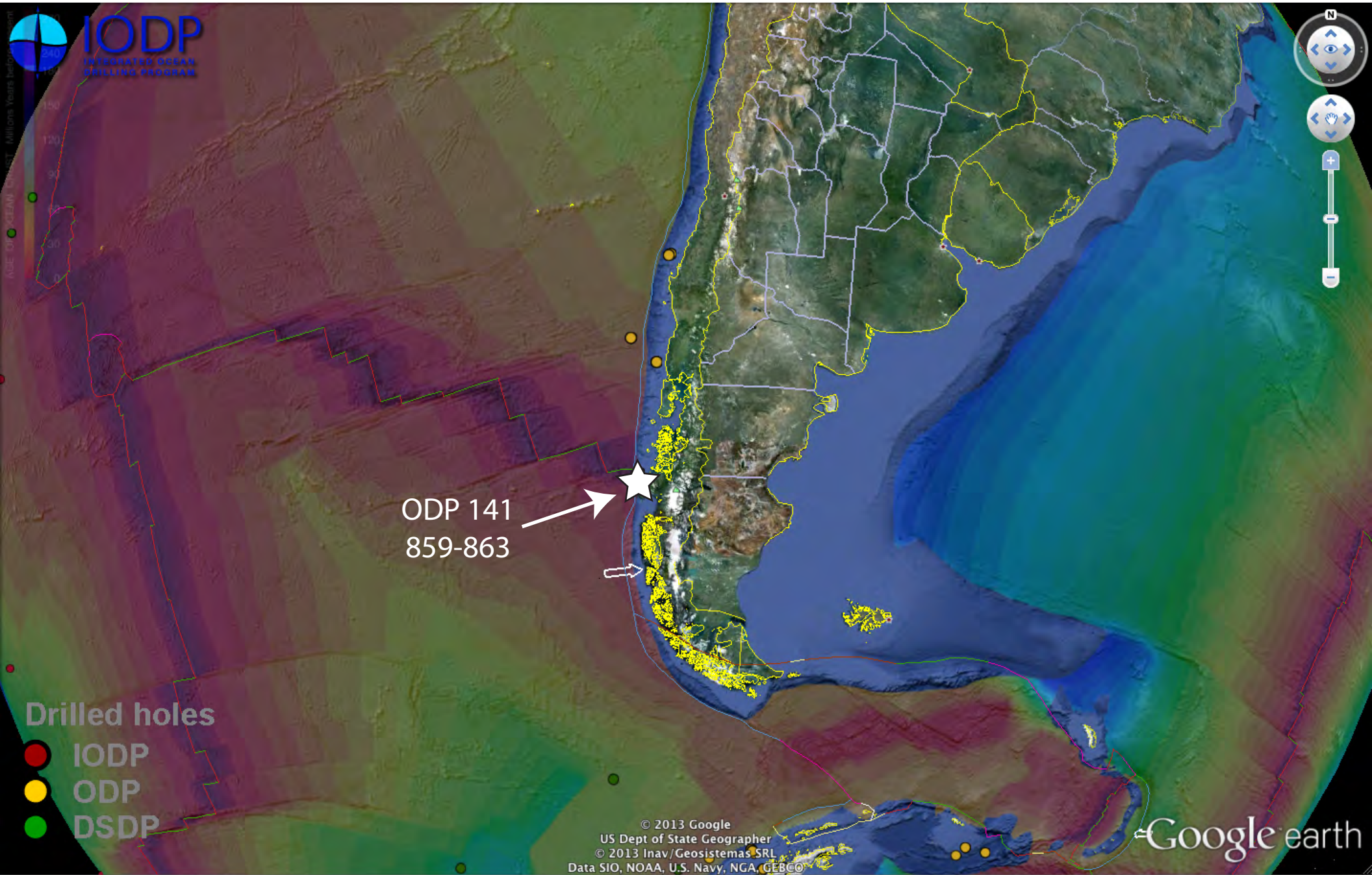
# COSTA RICA MARGIN DÉCOLLEMENT



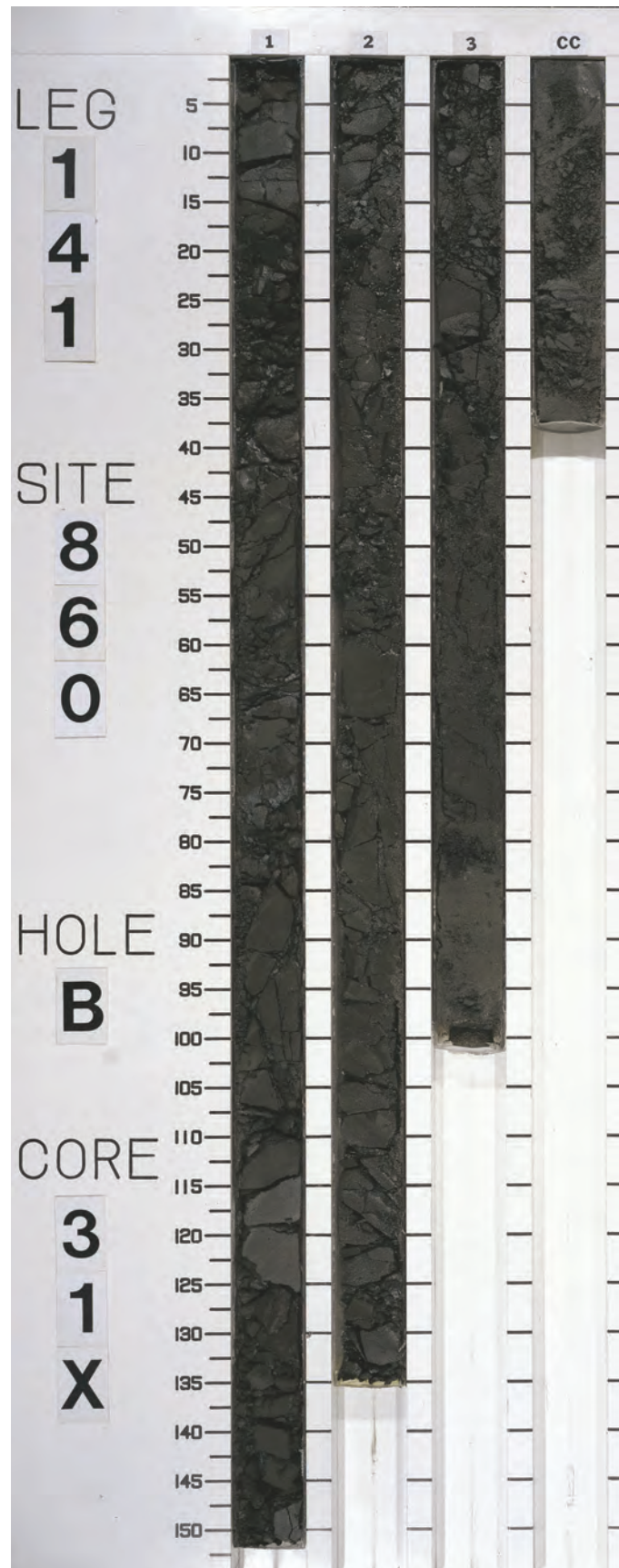
Interval 334-U1380A-10R-1, 42-82 cm



# Tectonically Deformed Sediments and Rocks in the GCR



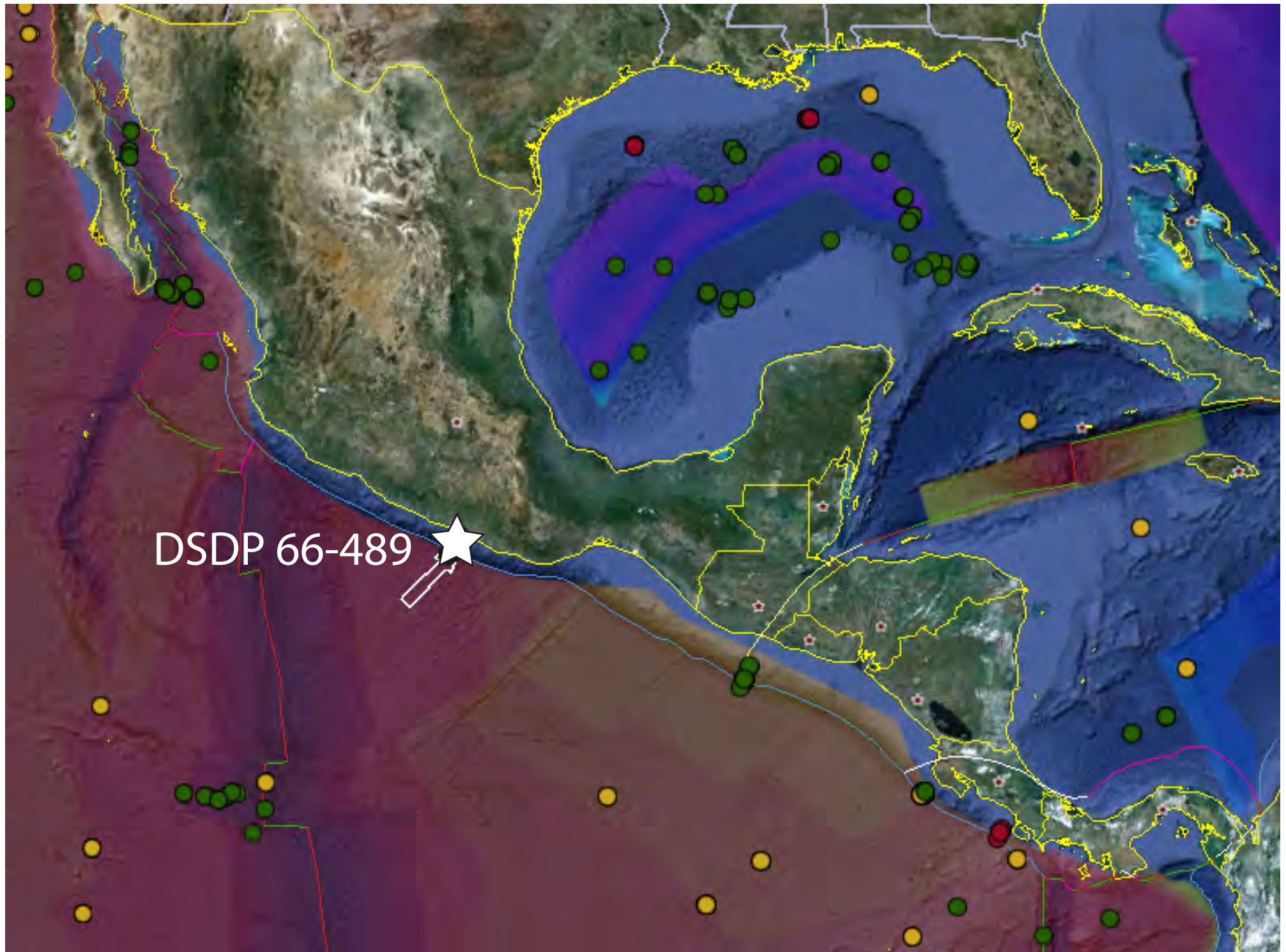
# CHILE TRIPLE JUNCTION EXTENSIONAL FAULT



## Continental Crust in Cores at the GCR

| Leg | Site | Region  |
|-----|------|---|
| 66  | 489  | Middle America Trench, southern Mexico margin |

# Continental Crust in Cores at the GCR





Shipboard Scientific Party, 1981.  
 Site 489. In: Watkins, J.S., Moore,  
 J.C., et al., Initial Reports  
 DSDP, 66: Washington (U.S.  
 Govt. Printing Office).

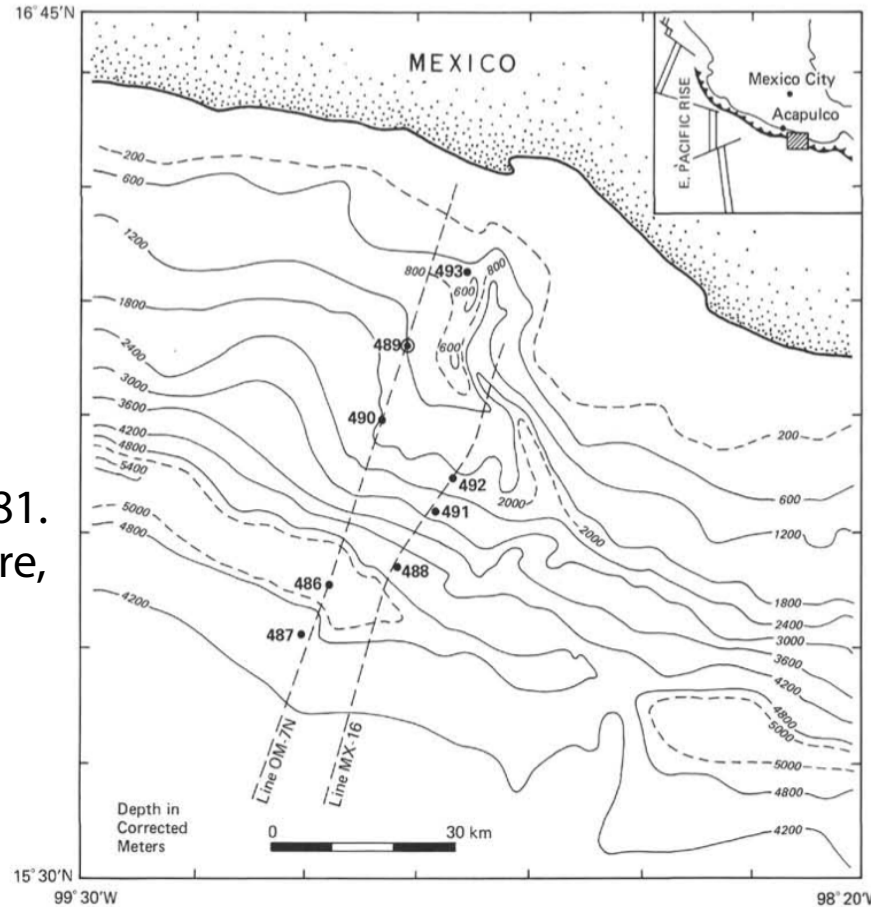


Figure 2. Site location map and index.

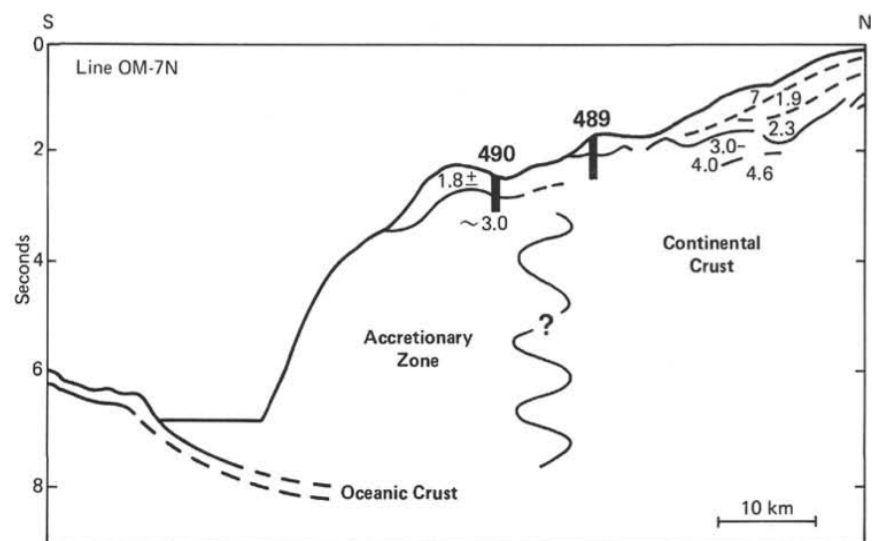


Figure 3. Schematic cross section of UTMSI multichannel Line OM-7N showing Sites 489 and 490, their relationship to the seaward edge of the continental crust, and seismic velocities observed in the area.

Shipboard Scientific Party,  
1981. Site 489. In: Watkins,  
J.S., Moore, J.C., et al., Initial  
Reports DSDP, 66:  
Washington (U.S. Govt.  
Printing Office).

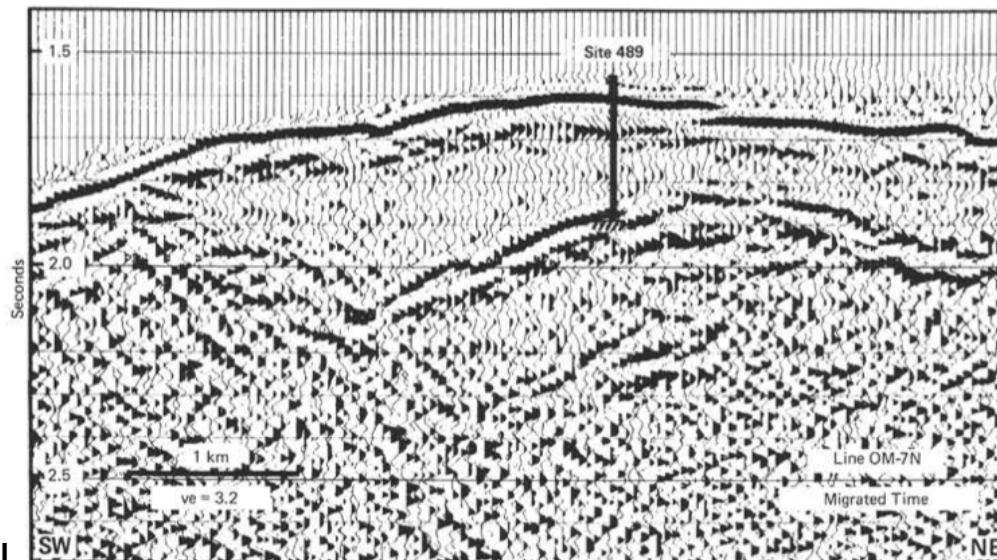


Figure 8. Multichannel seismic reflection profile through Site 489 parallel to regional dip.

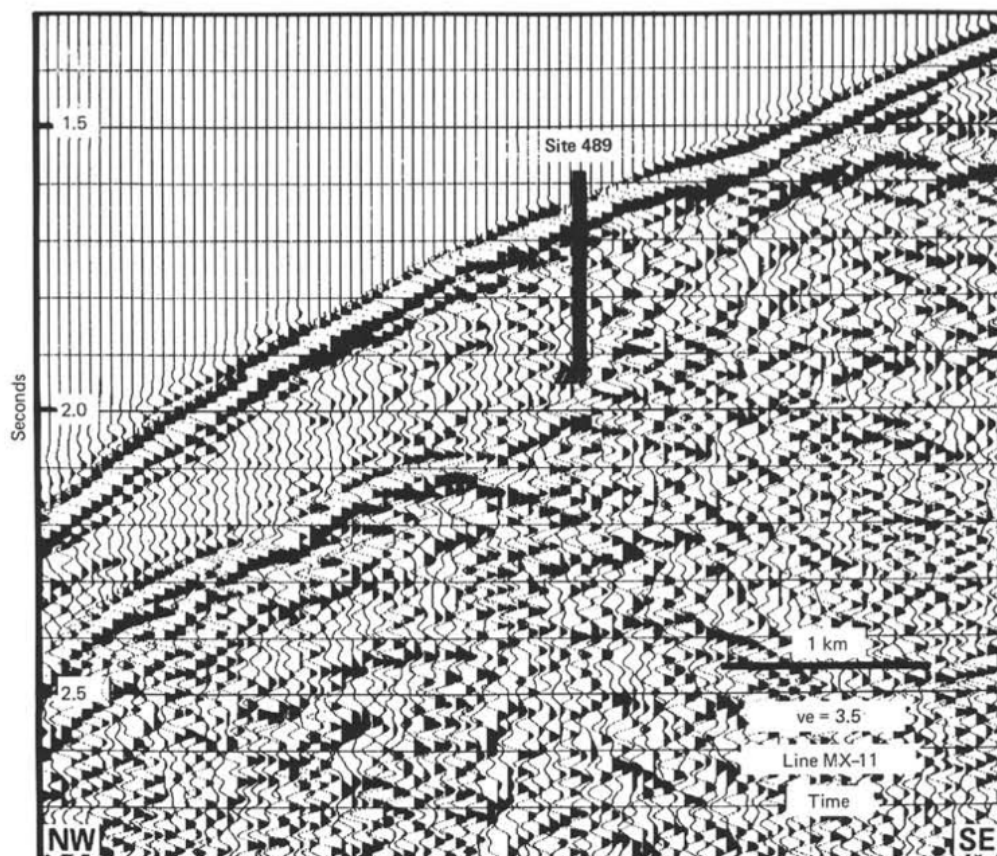


Figure 9. Multichannel seismic profile through Site 489 parallel to regional strike. Bottom topography reflects local basin to northwest of site.

# CONTINENTAL CRUST IN DSDP CORE



## SITE 489A, CORE 32, SECTION 1 and CORE-CATCHER, 300.0–309.0 m

### Macroscopic Description

Drilling breccia, fragments of BIOTITE-MUSCOVITE-QUARTZ SCHIST up to 2x3 cm. In upper 50 cm, rubble enclosed in medium light gray (N7) MUD. Schist is greenish black (5G 2/1) to medium bluish gray (5B 5/1). Subrounded schist pebble in Core-Catcher.

### Thin Section Description

Core-Catcher: Biotite-Muscovite-Quartz Schist

Biotite = common

Muscovite = common

## SITE 489A, CORE 33, SECTION 1, 309.0–318.0 m

### Macroscopic Description

BIOTITE-HORNBLENDE-QUARTZ SCHIST, with angular blocks of MUSCOVITE-CHLORITE-BEARING QUARTZITE. Crenulation foliation, dark gray (N3).

### Thin Section Descriptions

Section 1, 26–28 cm: Biotite-Hornblende-Quartz Schist

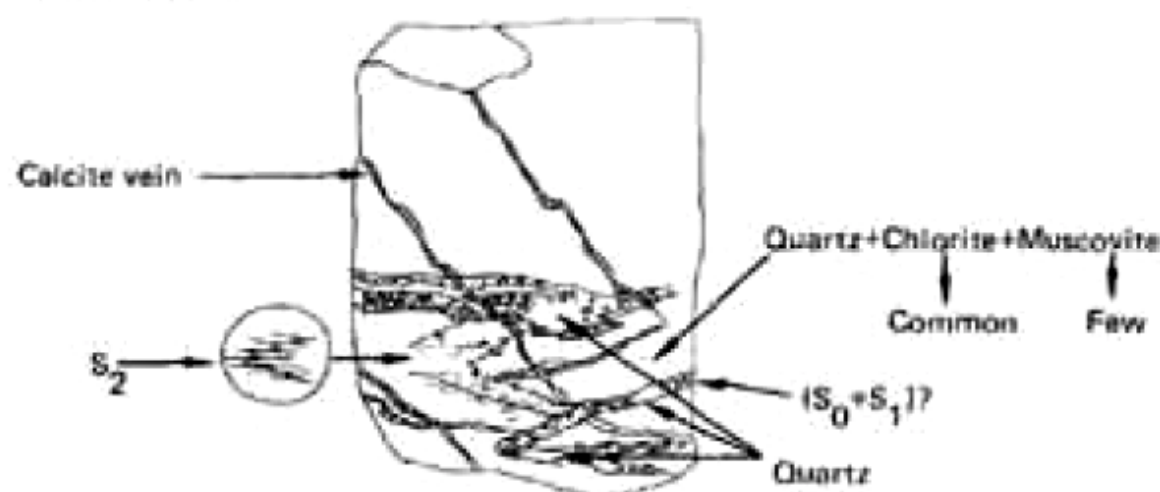
Biotite = common

Hornblende = abundant

Section 1, 40–42 cm: Muscovite-Chlorite-bearing Quartzite

Chlorite = common

Muscovite = few



## SITE 489A, CORE 34, SECTION 1, 318.0–327.0 m

### Macroscopic Description

GARNET-MUSCOVITE-QUARTZ SCHIST, dark gray (N3). Crenulation foliation. Pyrite-bearing. Smaller siliceous fragments, probably same as Core 33 (muscovite-chlorite-bearing quartzite).

### Thin Section Description:

Section 1, 35–37 cm: Garnet-Muscovite-Quartz Schist

Garnet = common

Muscovite = abundant



|  |            |                              |
|--|------------|------------------------------|
| <b>Paleozoic Cores from ODP at the GCR</b> |            |                              |
| <b>119</b>                                 | <b>740</b> | <b>Prydz Bay, Antarctica</b> |

References:

Keating, B.H., and Sakai, H., 1991. Amery Group Red Beds in Prydz Bay, Antarctica.

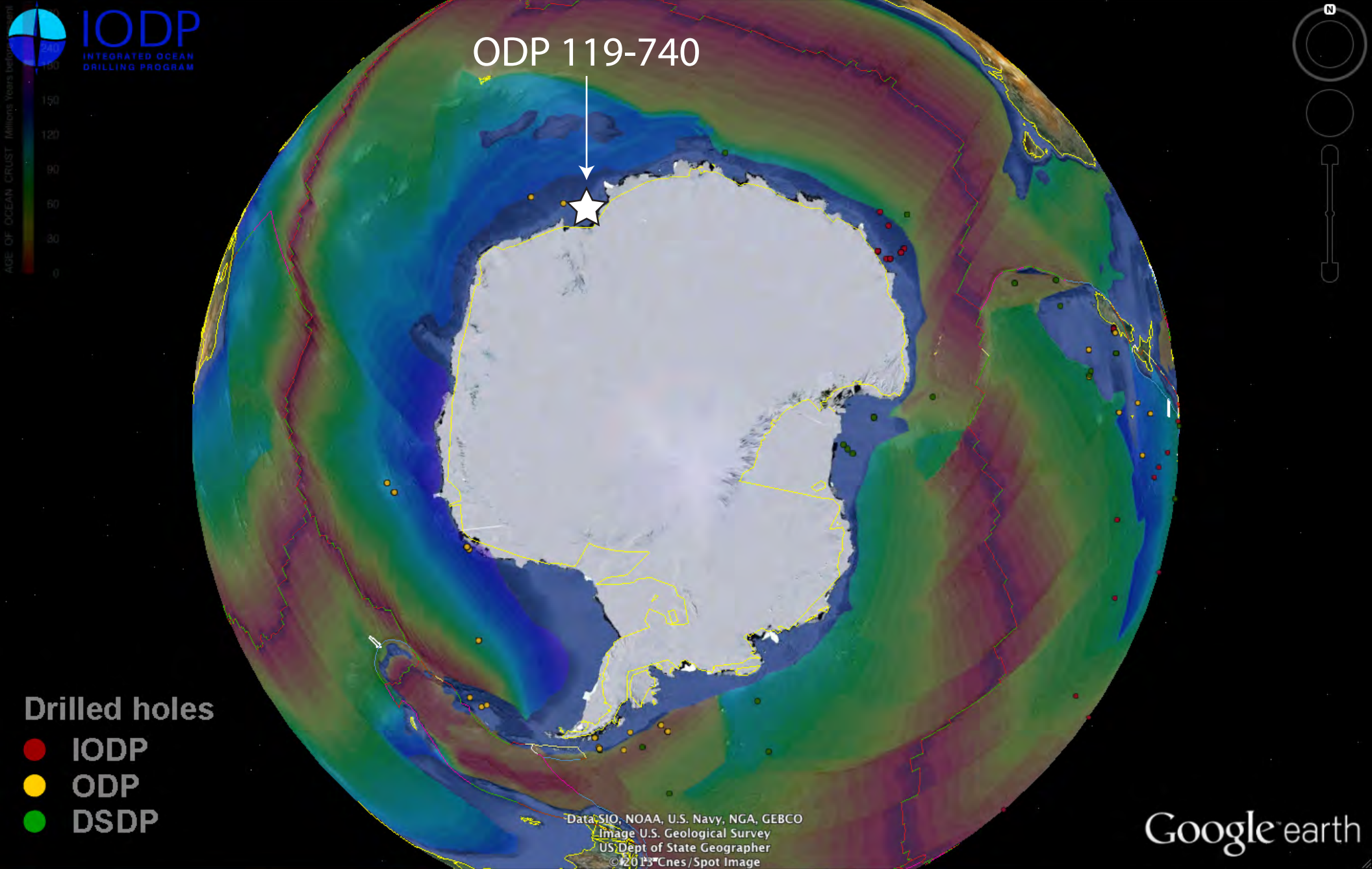
In: Barron, J., Larsen, B., et al. Proceedings of the Ocean Drilling Program, Scientific Results, 119: College Station, TX (Ocean Drilling Program), 795-809.

Truswell, E.M., 1991. Data Report: Palynology of Sediments from Leg 119 Drill Sites in Prydz

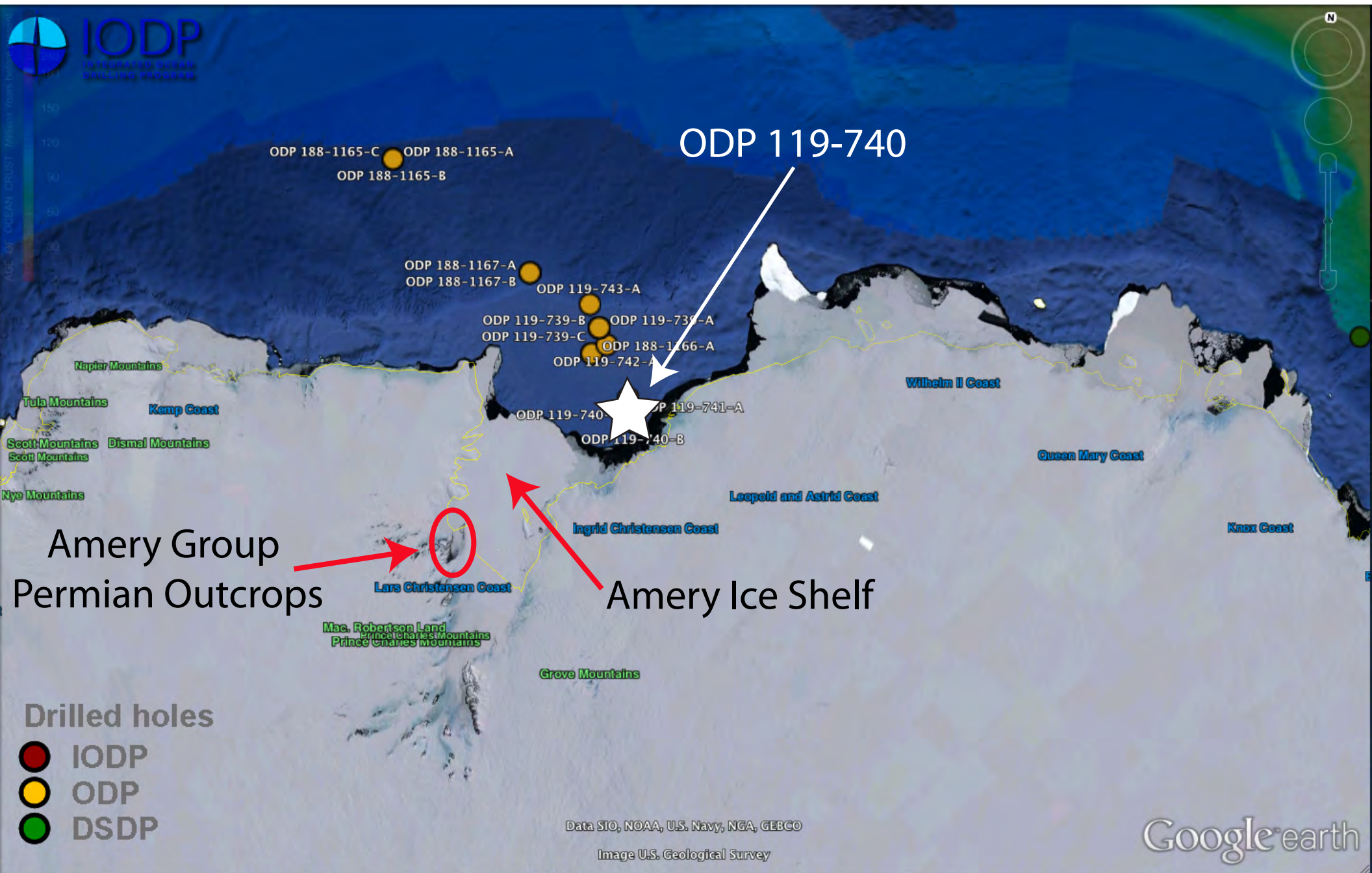
Bay, East Antarctica. In: Barron, J., Larsen, B., et al. Proceedings of the Ocean Drilling Program, Scientific Results, 119: College Station, TX (Ocean Drilling Program), 941-945.

Fielding, C. R., Ashworth, P.J., Best, J.L., Prokocki, E.W., and Sambrook Smith, G.H. 2012. Tributary, distributary and other fluvial patterns: What really represents the norm in the continental rock record? *Sedimentary Geology*, Volumes 261–262, 15 June 2012, Pages 15–32. <http://dx.doi.org/10.1016/j.sedgeo.2012.03.004>

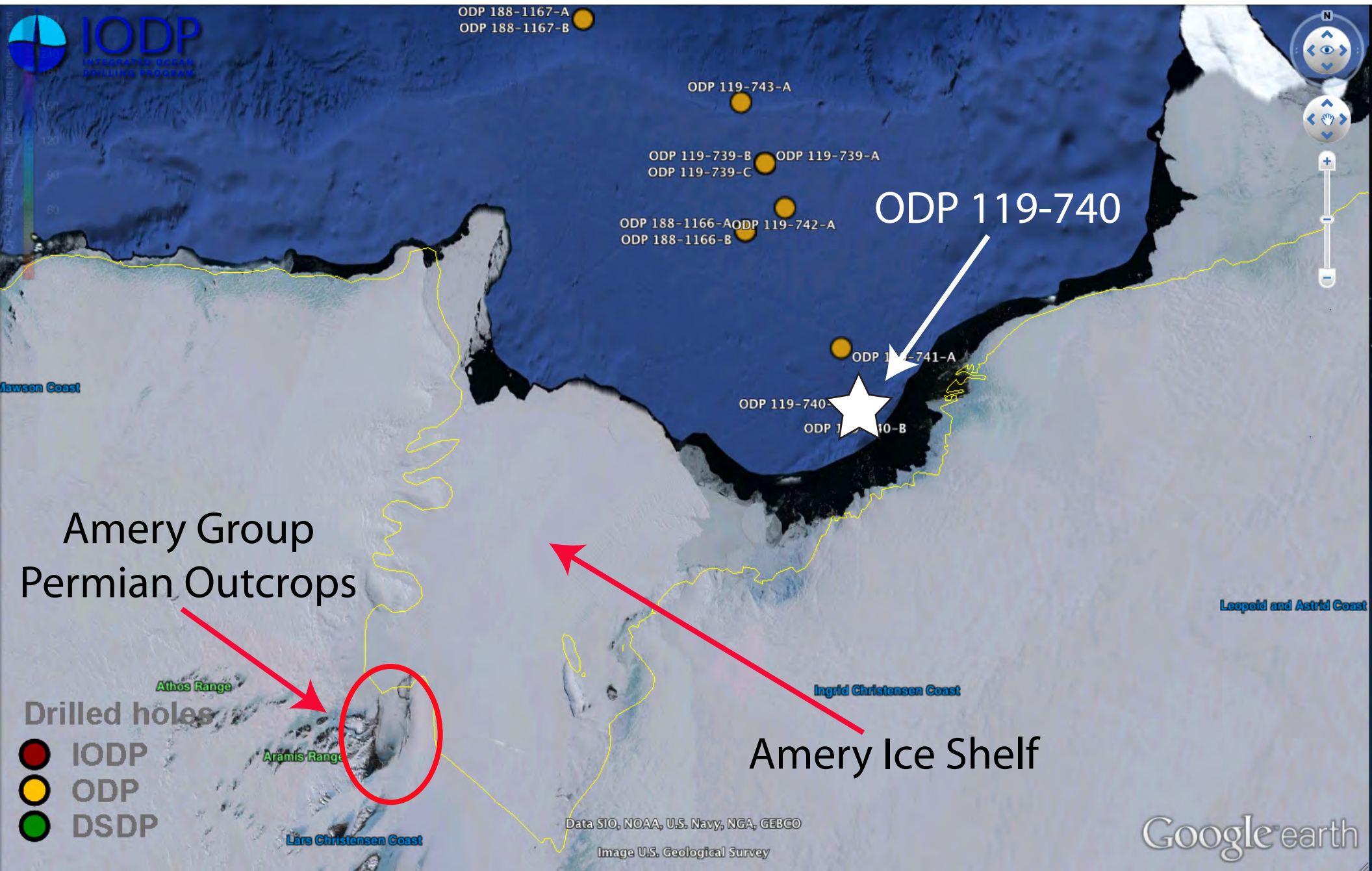
# Paleozoic Cores from ODP at the GCR: Leg 119 Site 740 Prydz Bay, Antarctica



# Location of Amery Ice Shelf and Permian Outcrops to ODP 119 Site 740



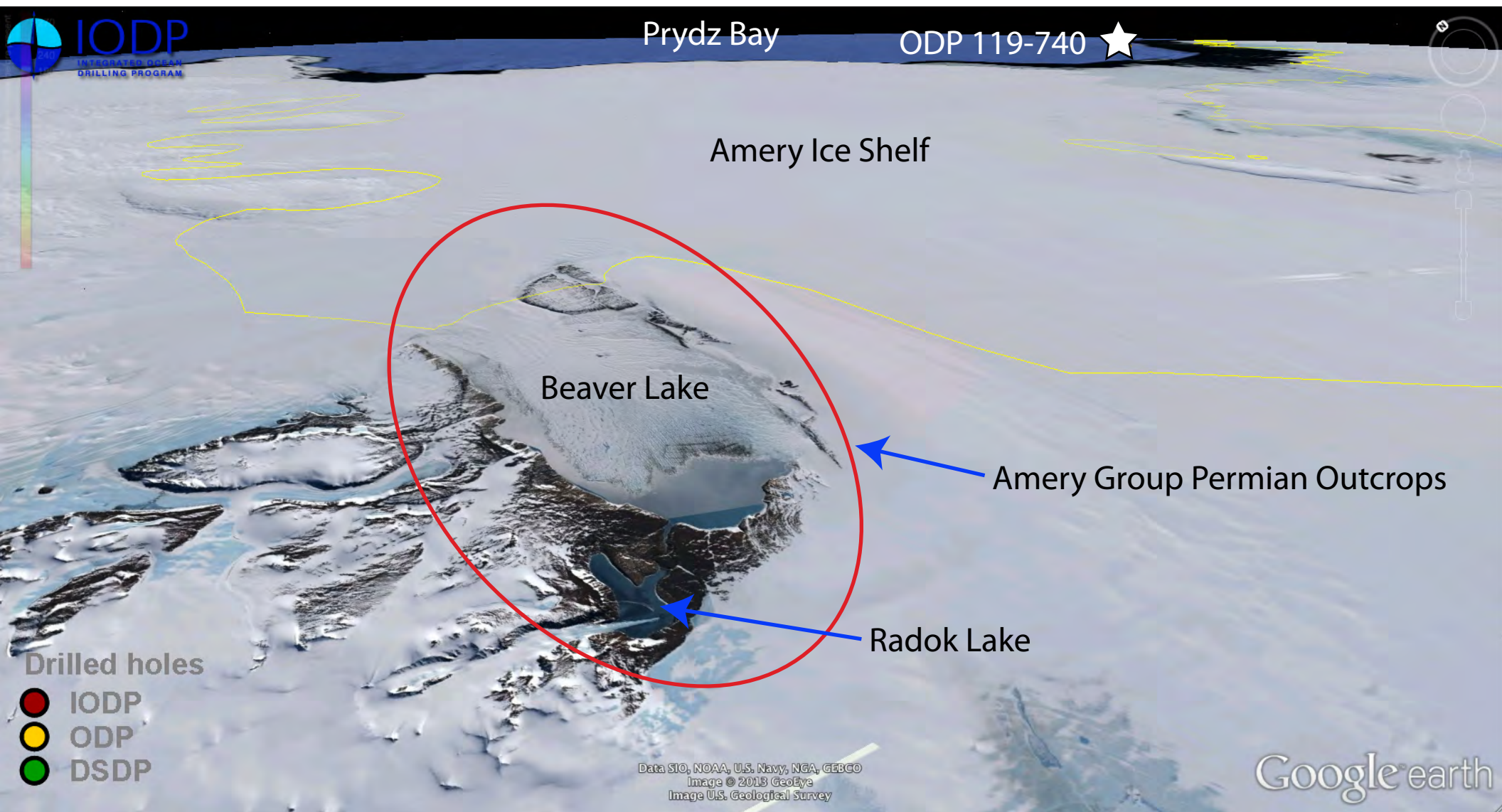
# Amery Ice Shelf and ODP 119 Site 740 Site Location



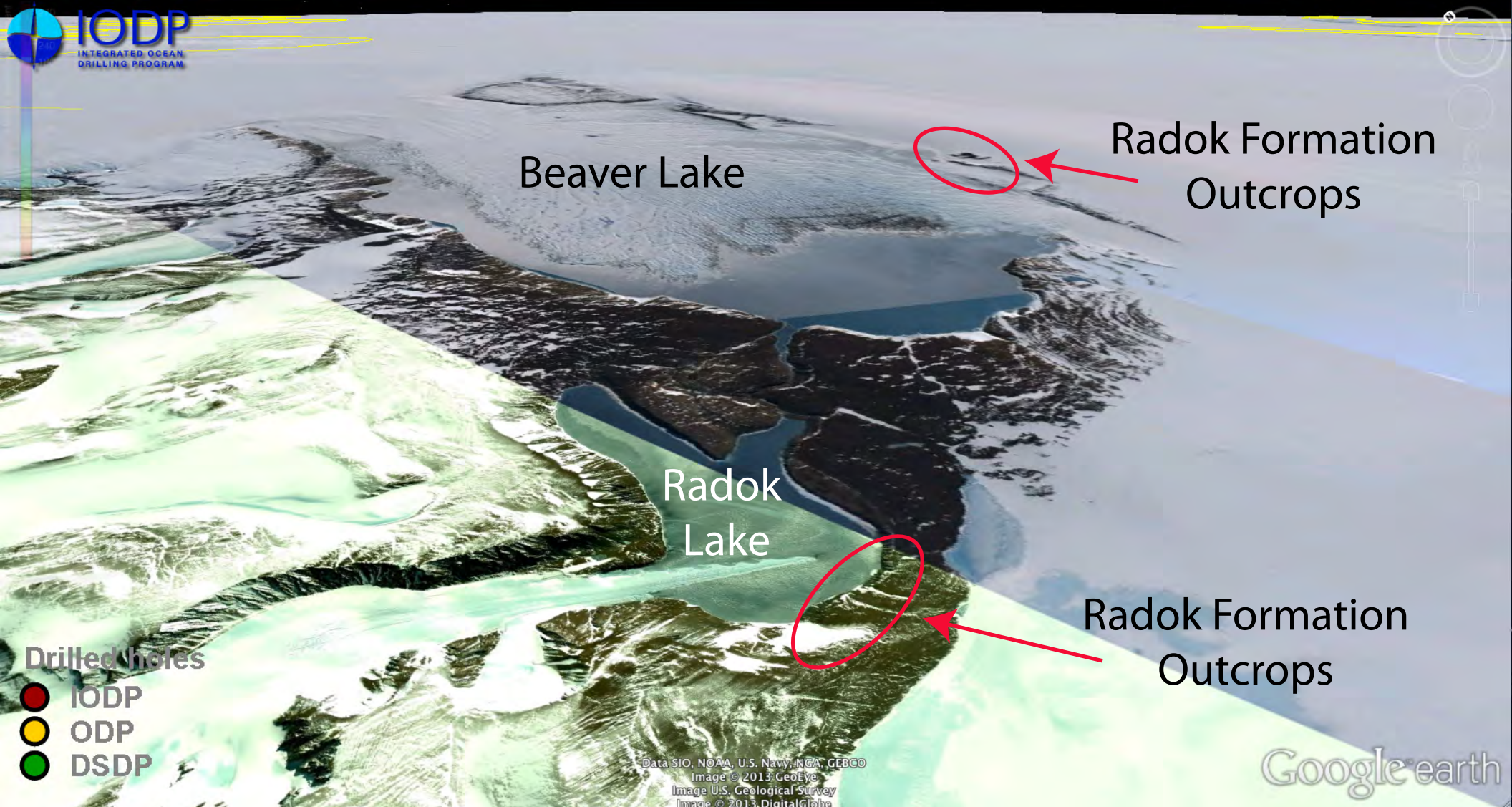




# Site Location of Amery Group Permian Outcrops



# Site Location of Amery Group Permian Outcrops



Beaver Lake

Radok Formation  
Outcrops

Radok  
Lake

Radok Formation  
Outcrops

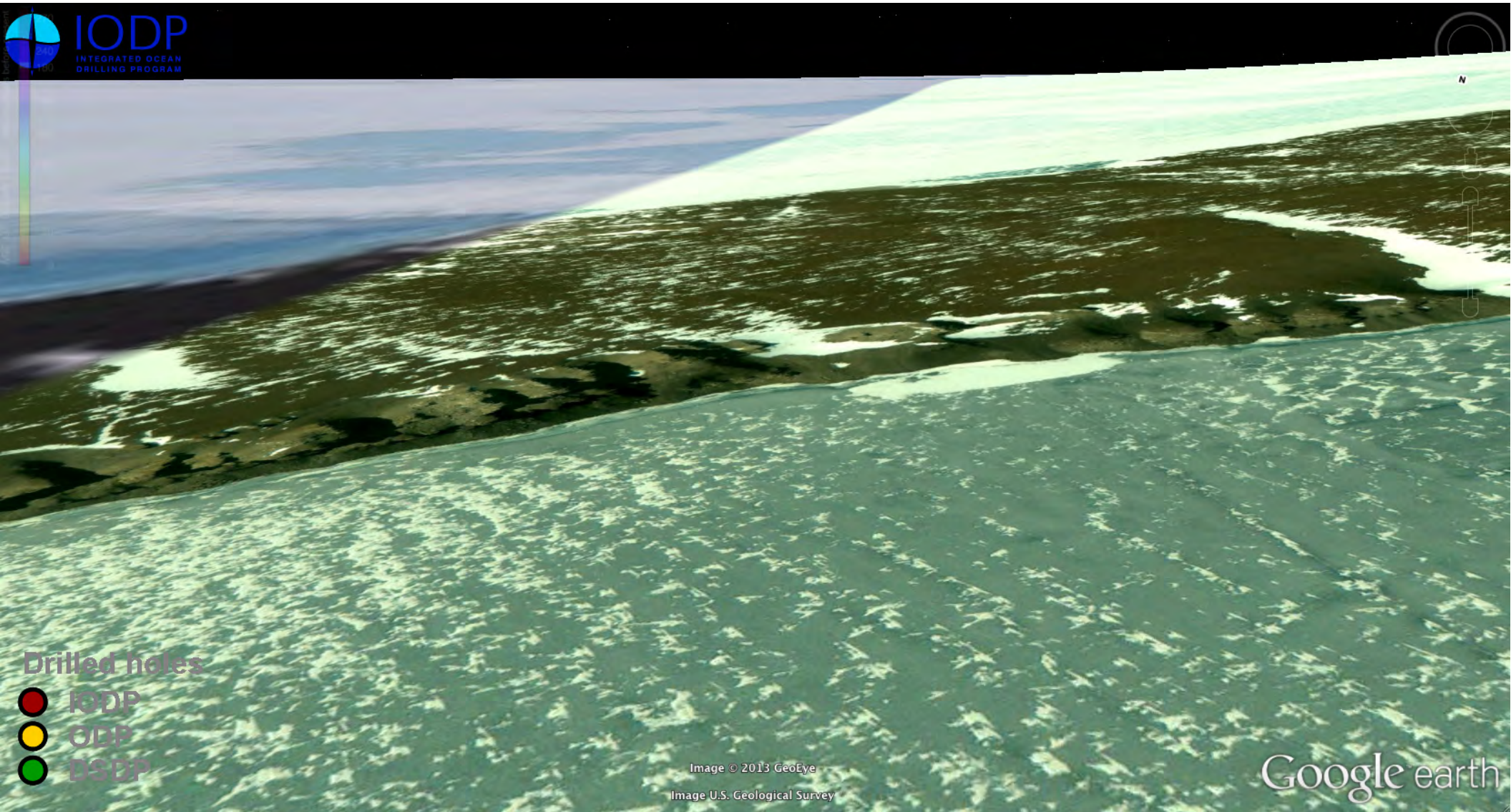
Drilled holes

- IODP
- ODP
- DSDP

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2013, GeoEye  
Image U.S. Geological Survey  
Image © 2013, DigitalGlobe

Google earth

# Permian Radok Formation Conglomerates and Sandstones Outcropping on the Southern Shore of Radok Lake



# Permian Radok Formation Conglomerates and Sandstones Outcropping on the Southern Shore of Radok Lake



Photograph from: Fielding, C. R., Ashworth, P.J., Best, J.L., Prokocki, E.W., and Sambrook Smith, G.H. 2012. Tributary, distributary and other fluvial patterns: What really represents the norm in the continental rock record? *Sedimentary Geology*, Volumes 261–262, 15 June 2012, Pages 15–32. <http://dx.doi.org/10.1016/j.sedgeo.2012.03.004>



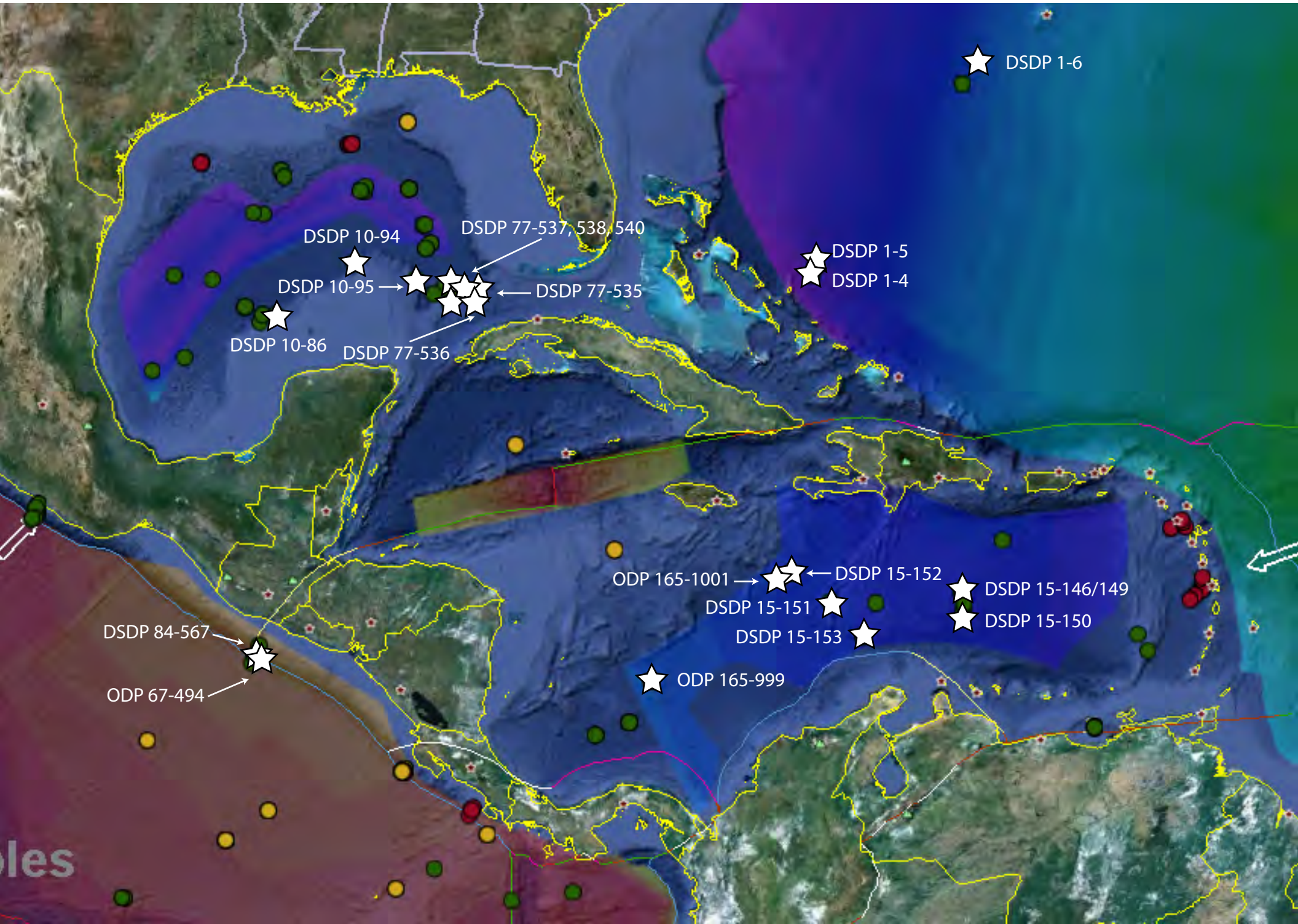
Permian Radok  
Formation Outcropping  
on Eastern Shore  
of Beaver Lake



## Mesozoic Cores from DSDP, ODP, IODP at the GCR

| DSDP Legs | Sites   | Ocean/Sea   |  | 32 | 303 | Pacific |  | ODP Legs | Sites | Ocean/Sea               | IODP Expeditio | Sites | Ocean/Sea |
|-----------|---------|-------------|--|----|-----|---------|--|----------|-------|-------------------------|----------------|-------|-----------|
| 1         | 4       | N. Atlantic |  |    | 304 | Pacific |  | 113      | 689   | Weddell Sea, Antarctica | 324            | 1346  | Pacific   |
|           | 5       | N. Atlantic |  |    | 305 | Pacific |  |          | 690   | Weddell Sea, Antarctica |                | 1347  | Pacific   |
|           | 6       | N. Atlantic |  |    | 306 | Pacific |  |          | 692   | Weddell Sea, Antarctica |                | 1348  | Pacific   |
| 6         | 47      | Pacific     |  |    | 307 | Pacific |  |          | 693   | Weddell Sea, Antarctica |                | 1349  | Pacific   |
|           | 48      | Pacific     |  |    | 310 | Pacific |  | 119      | 740   | Prydz Bay, Antarctica   |                | 1350  | Pacific   |
|           | 49      | Pacific     |  |    | 313 | Pacific |  |          | 741   | Prydz Bay, Antarctica   | 329            | 1370  | Pacific   |
|           | 50      | Pacific     |  | 33 | 315 | Pacific |  | 129      | 800   | Pacific                 |                | 1371  | Pacific   |
|           | 51      | Pacific     |  |    | 316 | Pacific |  |          | 801   | Pacific                 | 330            | 1372  | Pacific   |
|           | 52      | Pacific     |  |    | 317 | Pacific |  |          | 802   | Pacific                 |                | 1373  | Pacific   |
| 7         | 61      | Pacific     |  | 61 | 462 | Pacific |  | 130      | 803   | Pacific                 |                | 1374  | Pacific   |
|           | 66      | Pacific     |  | 62 | 463 | Pacific |  |          | 807   | Pacific                 |                | 1376  | Pacific   |
| 10        | 86      | GOM         |  |    | 464 | Pacific |  | 132      | 810   | Pacific                 |                |       |           |
|           | 94      | GOM         |  |    | 465 | Pacific |  | 136      | 842   | Pacific                 |                |       |           |
|           | 95      | GOM         |  |    | 466 | Pacific |  |          | 843   | Pacific                 |                |       |           |
|           | 97      | GOM         |  | 77 | 535 | GOM     |  | 143      | 865   | Pacific                 |                |       |           |
| 15        | 146/149 | Caribbean   |  |    | 536 | GOM     |  |          | 866   | Pacific                 |                |       |           |
|           | 150     | Caribbean   |  |    | 537 | GOM     |  |          | 867   | Pacific                 |                |       |           |
|           | 151     | Caribbean   |  |    | 538 | GOM     |  |          | 868   | Pacific                 |                |       |           |
|           | 152     | Caribbean   |  |    | 540 | GOM     |  | 144      | 872   | Pacific                 |                |       |           |
|           | 153     | Caribbean   |  | 67 | 494 | Pacific |  |          | 873   | Pacific                 |                |       |           |
| 16        | 163     | Pacific     |  | 84 | 567 | Pacific |  |          | 874   | Pacific                 |                |       |           |
| 17        | 164     | Pacific     |  | 86 | 576 | Pacific |  |          | 875   | Pacific                 |                |       |           |
|           | 165     | Pacific     |  |    | 577 | Pacific |  |          | 876   | Pacific                 |                |       |           |
|           | 166     | Pacific     |  |    | 578 | Pacific |  |          | 877   | Pacific                 |                |       |           |
|           | 167     | Pacific     |  | 89 | 462 | Pacific |  |          | 878   | Pacific                 |                |       |           |
|           | 169     | Pacific     |  |    | 585 | Pacific |  |          | 879   | Pacific                 |                |       |           |
|           | 170     | Pacific     |  | 91 | 595 | Pacific |  | 145      | 883   | Pacific                 |                |       |           |
|           | 171     | Pacific     |  |    | 596 | Pacific |  | 165      | 999   | Caribbean               |                |       |           |
| 19        | 192     | Pacific     |  |    |     |         |  |          | 1001  | Caribbean               |                |       |           |
| 20        | 194     | Pacific     |  |    |     |         |  | 181      | 1124  | Pacific                 |                |       |           |
|           | 195     | Pacific     |  |    |     |         |  | 185      | 1149  | Pacific                 |                |       |           |
|           | 196     | Pacific     |  |    |     |         |  | 192      | 1183  | Pacific                 |                |       |           |
|           | 197     | Pacific     |  |    |     |         |  |          | 1185  | Pacific                 |                |       |           |
|           | 198     | Pacific     |  |    |     |         |  |          | 1186  | Pacific                 |                |       |           |
|           | 199     | Pacific     |  |    |     |         |  |          | 1187  | Pacific                 |                |       |           |
| 21        | 204     | Pacific     |  |    |     |         |  | 197      | 1203  | Pacific                 |                |       |           |
| 29        | 275     | Pacific     |  |    |     |         |  |          | 1204  | Pacific                 |                |       |           |
| 30        | 288     | Pacific     |  |    |     |         |  | 198      | 1207  | Pacific                 |                |       |           |
|           | 289     | Pacific     |  |    |     |         |  |          | 1208  | Pacific                 |                |       |           |
|           |         |             |  |    |     |         |  |          | 1212  | Pacific                 |                |       |           |
|           |         |             |  |    |     |         |  |          | 1213  | Pacific                 |                |       |           |
|           |         |             |  |    |     |         |  |          | 1214  | Pacific                 |                |       |           |

# Mesozoic Cores from DSDP, ODP, IODP at the GCR: Atlantic Ocean, Caribbean and Gulf of Mexico





# DSDP Leg 67, Hole 464A, Core 28R, Section 1

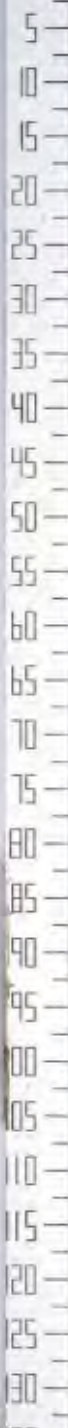
SITE 494 HOLE A CORE 28 CORED INTERVAL 294.0-303.0 m

| TIME - ROCK UNIT           | BIOSTRATIGRAPHIC ZONE                                   | FOSSIL CHARACTER |              |              |          | SECTION    | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION  |
|----------------------------|---|------------------|--------------|--------------|----------|------------|--------|-------------------|---|---------|---|
|                            |   | FORAMINIFERS     | NANNOFOSSILS | RADIOLARIANS | DIA TOMS |            |        |                   |   |         |   |
| MAASTRICHTIAN              |   | AP               | CM           | RP           |          |            |        |                   |   |         |   |
| Upper Cret. and Eocene (R) | <i>G. gansseri</i> (F)<br>Upper Cret. and M. Eocene (N) | AP               |              |              |          | 0.5<br>1.0 |        |                   |   |         | <p>← One fragment (6 cm) of silty limestone</p> <p><b>DRILL BRECCIA</b><br/>Top of Section 1 - one fragment of silty limestone. Remainder of core is drill breccia with 65-80 cm intact but fractured light gray (5G 6/1) firm silty micritic chalk (10% silt).</p> <p><b>SMEAR SLIDE SUMMARY</b></p> <p style="text-align: right;">1-70</p> <p>TEXTURE:</p> <p>Sand -</p> <p>Silt 10</p> <p>Clay 90</p> <p>COMPOSITION:</p> <p>Quartz 4</p> <p>Feldspar 3</p> <p>Pyrite 1</p> <p>Other heavy minerals 1</p> <p>Clay minerals 57</p> <p>Volcanic glass 1</p> <p>Zeolite 5</p> <p>Calc.-Dolo.-Arag. 28</p> |



# DSDP Leg 84, Hole 567A, Core 19, Section 1

**LEG 84**  
**SITE 567**  
**HOLE A**  
**CORE 19**



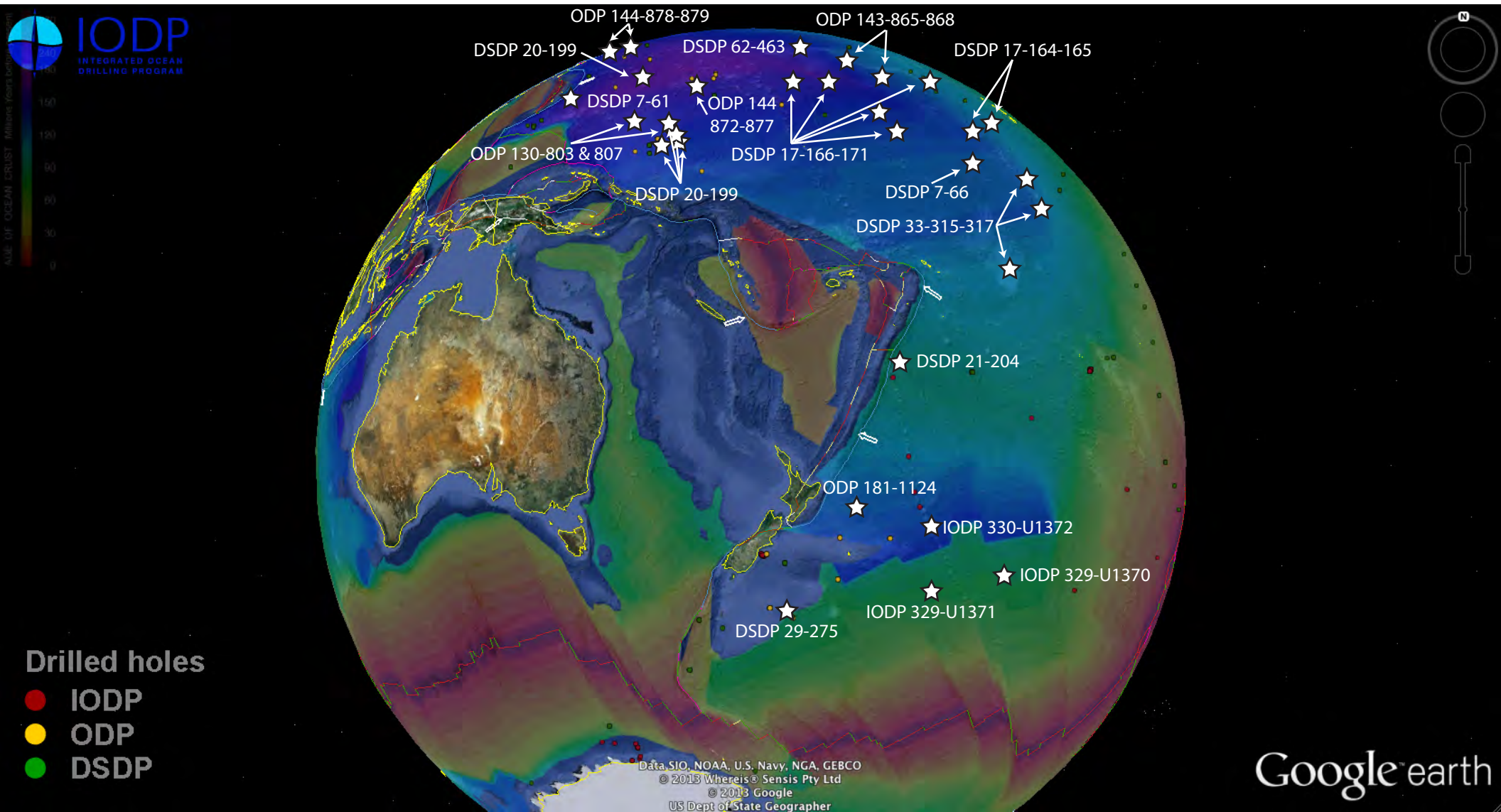
SITE 567 HOLE A CORE 19 CORED INTERVAL 358.7-368.4 m sub-bottom

| TIME - ROCK UNIT                     | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER |              |              |         | SECTION | METERS     | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION  |  |
|--------------------------------------|-----------------------|------------------|--------------|--------------|---------|---------|------------|-------------------|---|---------|---|--|
|                                      |                       | FORAMINIFERS     | NANNOFOSSILS | RADIOLARIANS | DIATOMS |         |            |                   |   |         |   |  |
| Cretaceous (Campanian-Maastrichtian) | A                     |                  |              |              |         | 1       | 0.5<br>1.0 | bed               |   | * *     | Drilling breccia limestone cuttings<br><br>Pale red (10R 6/2) mottle limestone<br><br>Pale green (10G 6/2) mottled limestone - well bedded<br><br>Pale greenish yellow (10Y 8/2) to very pale orange (10YR 8/2) mottled limestone<br><br>Igneous rock | Dominant lithology: limestone. Color: pale red (10R 6/2) to pale greenish yellow (10Y 8/2).<br><br>Mottled limestone, Fractured throughout. Some bedding visible.<br><br>Minor lithology: dolerite. Color: grayish green (10G 4/2).  |
|                                      |                       |                  |              |              |         | CC      |            | (CC)              |   |         |   | SMEAR SLIDE SUMMARY (%):<br>1, 7<br><br>Texture:<br>Sand 30<br>Silt 50<br>Clay 20<br><br>Composition:<br>Quartz 10<br>Feldspar 5<br>Mica 1<br>Heavy minerals 2<br>Clay 10<br>Volcanic glass 3<br>Glauconite 1<br>Pyrite 3<br>Carbonate unsp. 52<br>Calc. nannofossils 5<br>Diatoms 1<br>Radiolarians 1<br>Sponge spicules 1<br>Serpentinite 3<br><br>CARBONATE BOMB (% CaCO <sub>3</sub> ):<br>1, 8 cm = 25<br>1, 85 cm = 58 |

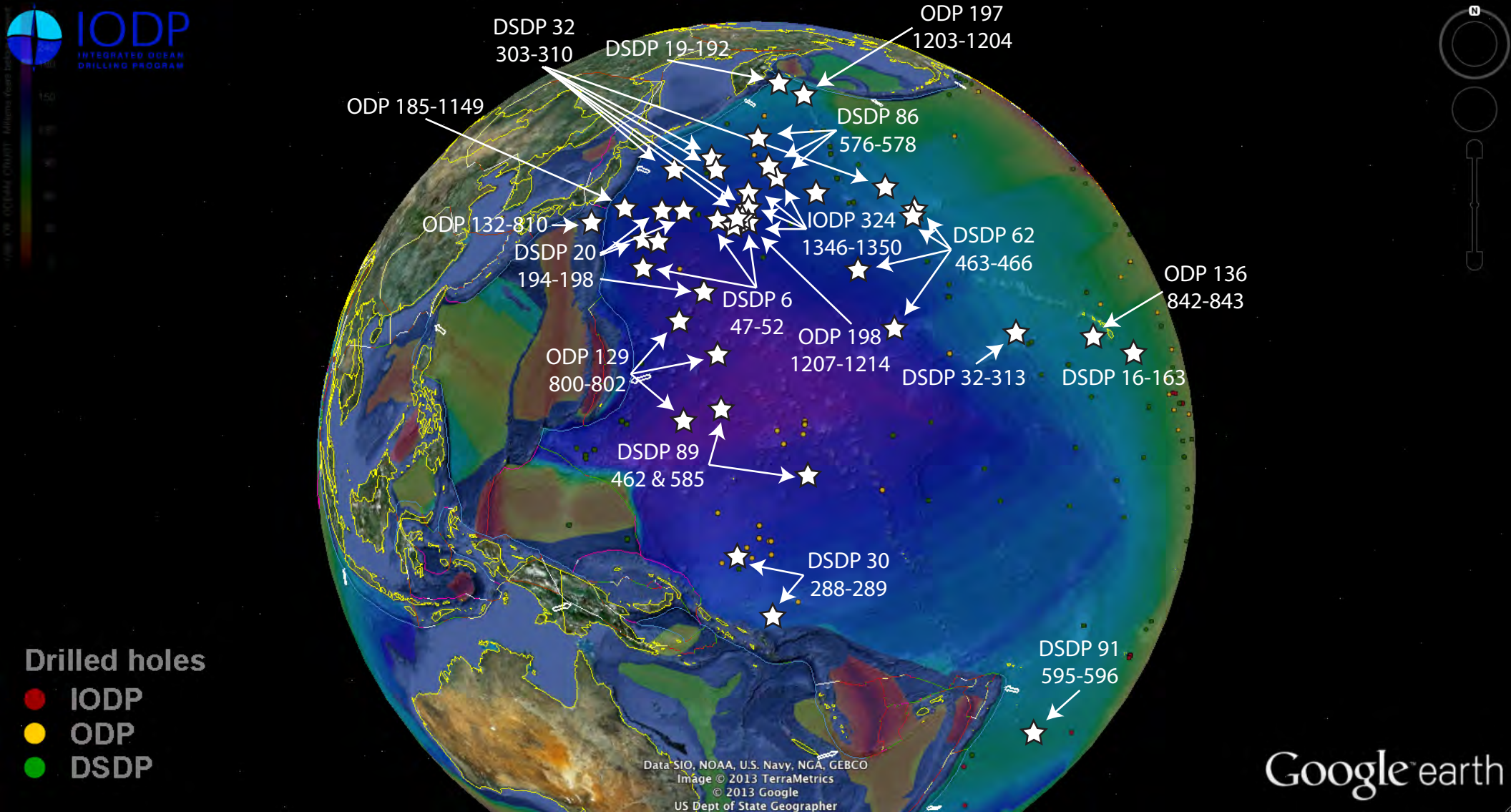
Section 1, 70 cm: fractures



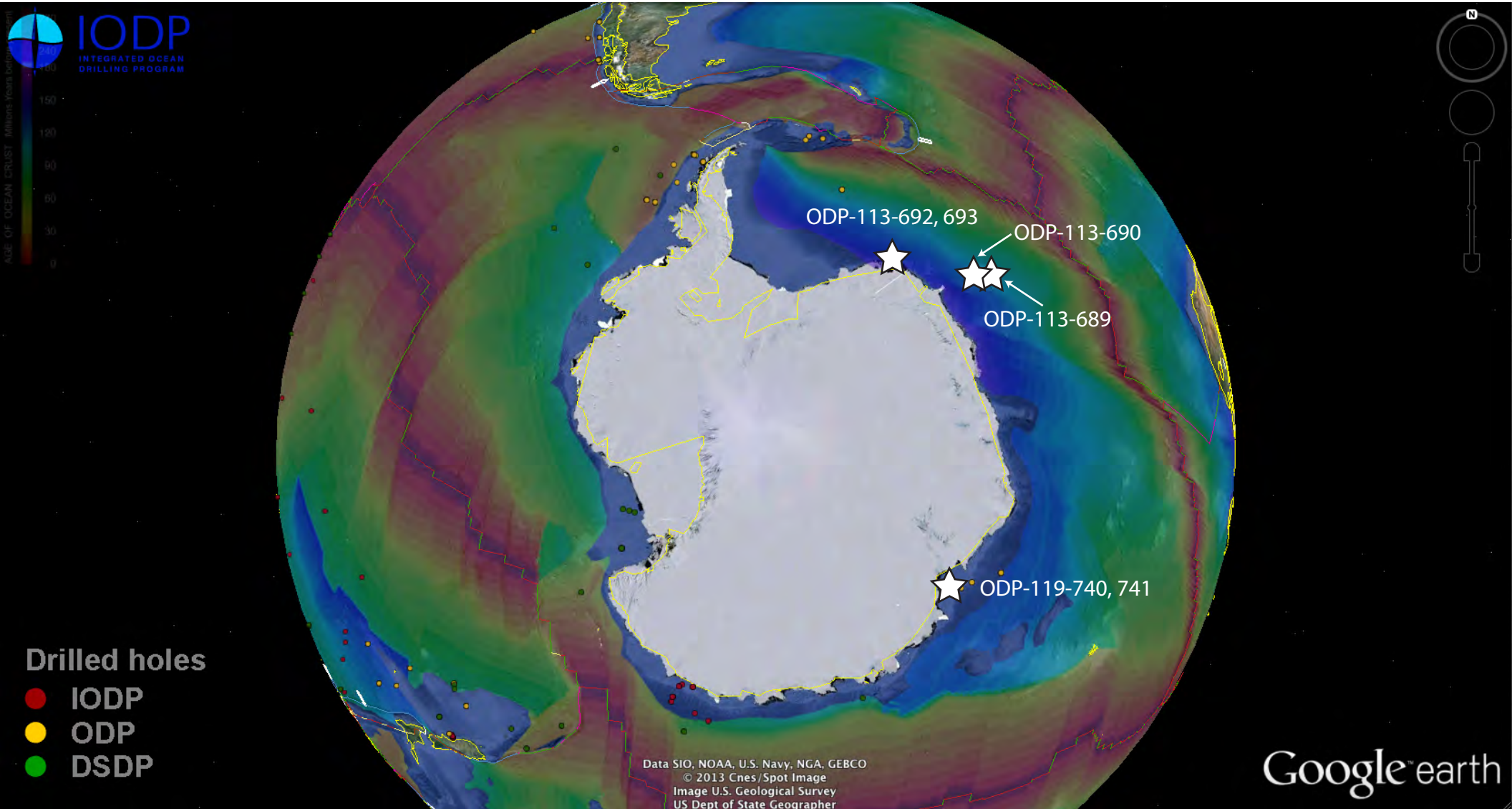
# Mesozoic Cores from DSDP, ODP, IODP at the GCR: Southwestern Pacific Ocean



# Mesozoic Cores from DSDP, ODP, IODP at the GCR Western Pacific Ocean



# Mesozoic Cores from DSDP, ODP, IODP at the GCR: Weddell Sea and Prydz Bay, Antarctica



# Section 113-692B-7R-2



mid-Cretaceous shale  
with ash layers

# Section 113-692B-10R-4

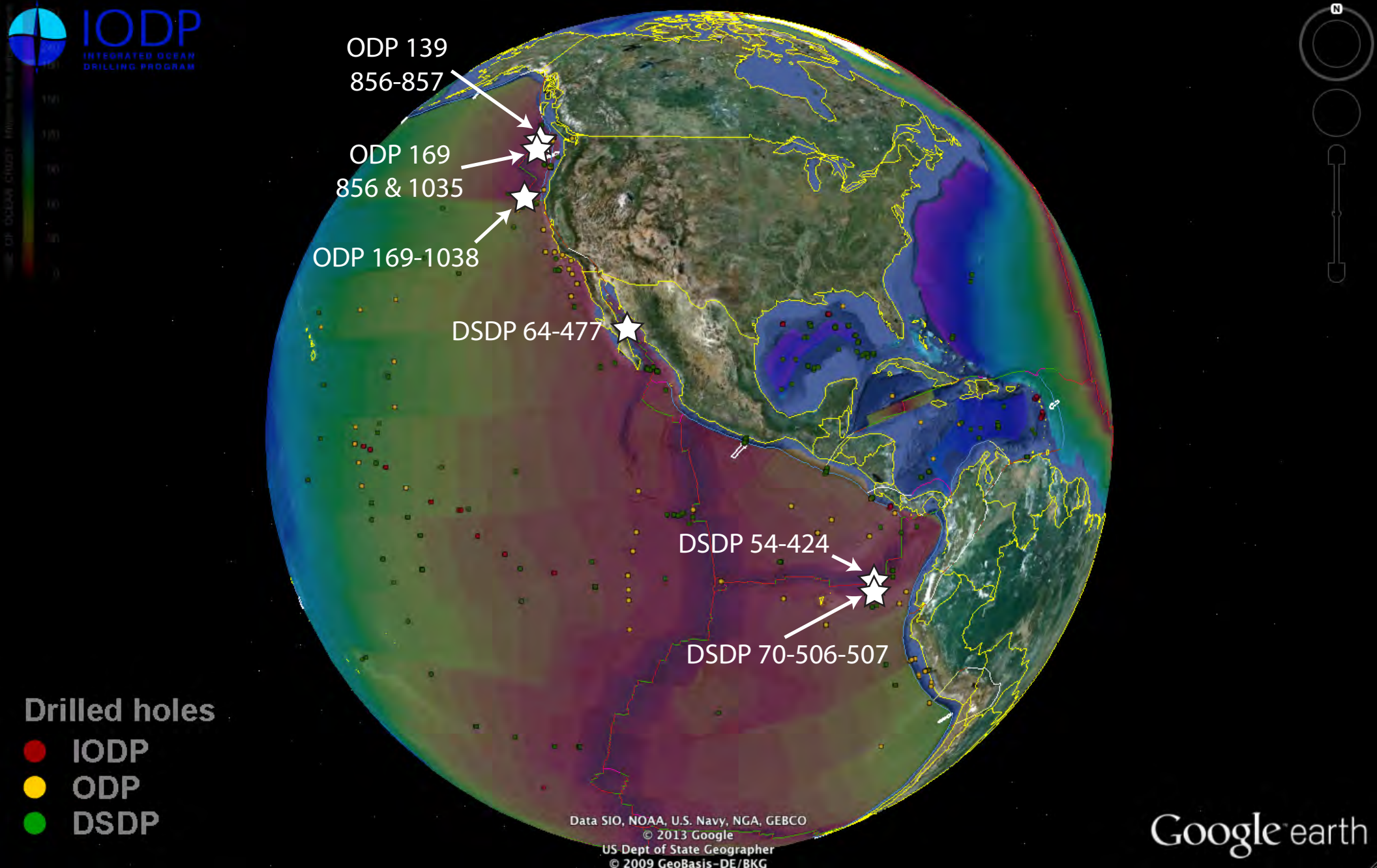


mid-Cretaceous shale  
with ash layers

**HYDROTHERMAL DEPOSITS CORED BY DSDP,ODP STORED AT THE GCR**

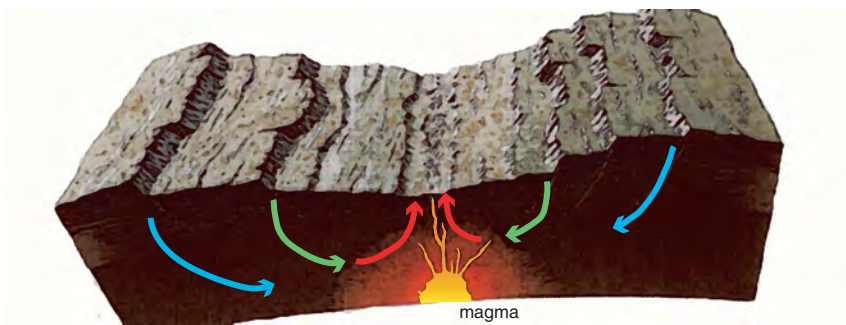
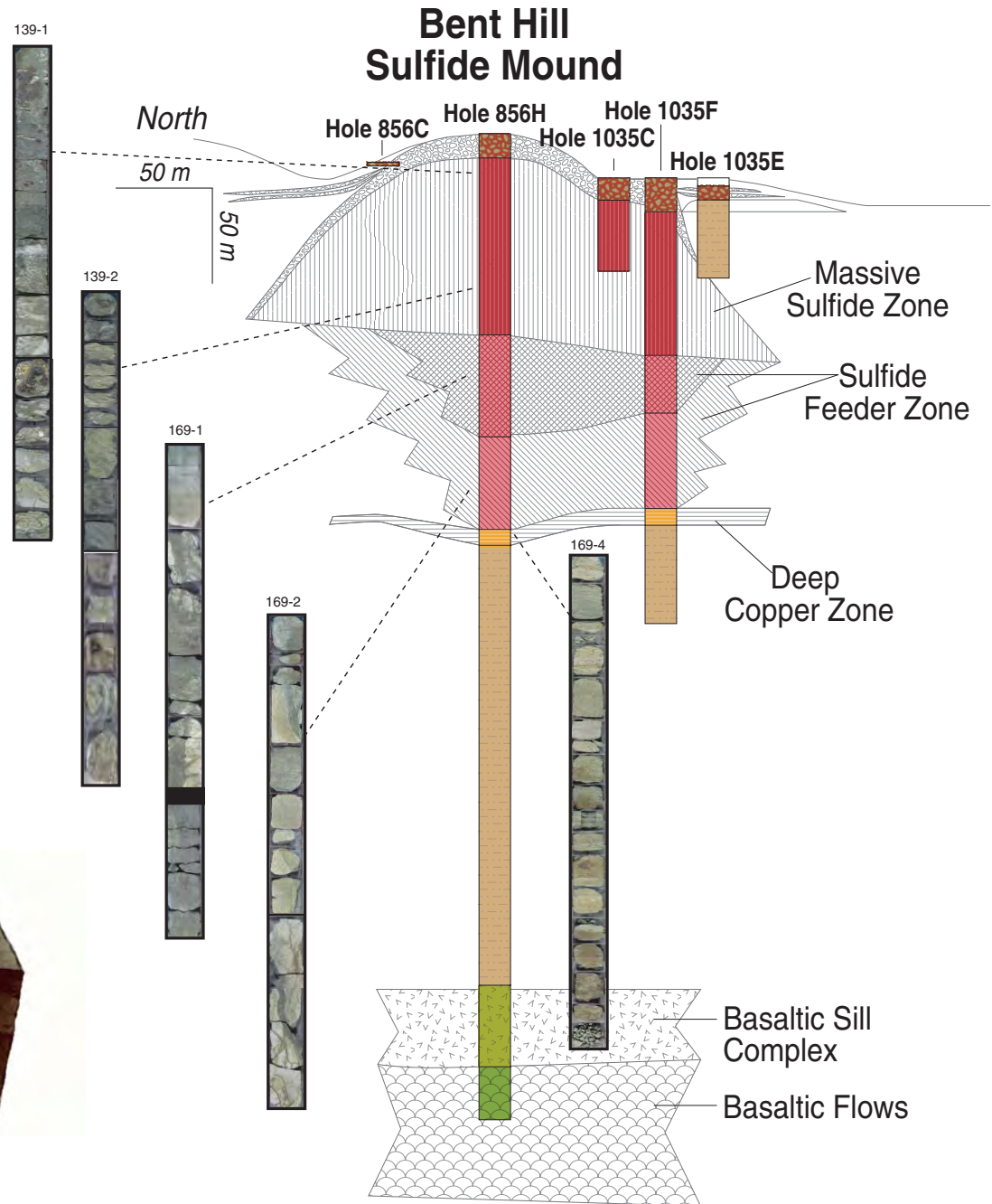
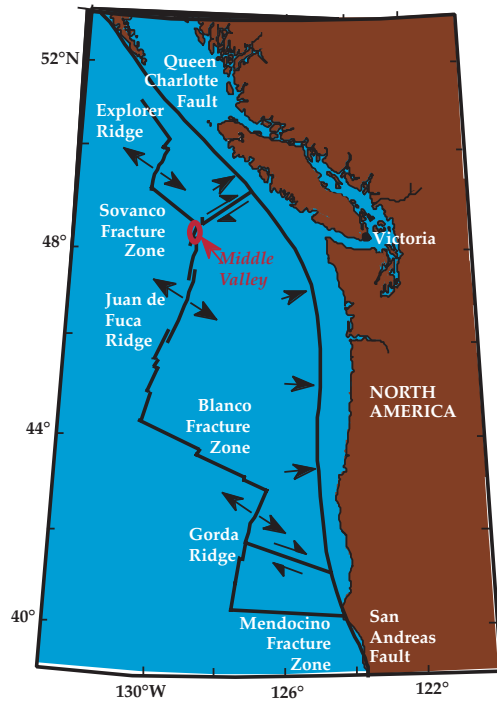
| Leg | Site | Region/Feature                    |
|-----|------|-----------------------------------|
| 54  | 424  | Galapagos Rift                    |
| 64  | 477  | Guaymas Basin, Gulf of California |
| 70  | 506  | Galapagos Rift                    |
|     | 507  | Galapagos Rift                    |
| 139 | 856  | Middle Valley, Juan de Fuca Ridge |
|     | 857  | Middle Valley, Juan de Fuca Ridge |
| 169 | 856  | Middle Valley, Juan de Fuca Ridge |
|     | 1035 | Middle Valley, Juan de Fuca Ridge |
|     | 1038 | Escanaba Trough                   |

# Hydrothermal Deposits Cored by DSDP, ODP Stored at the GCR





# SEAFLOOR HYDROTHERMAL MASSIVE SULFIDE DEPOSITS OCEAN DRILLING PROGRAM, LEGS 139 AND 169



Modified from Miller, 2001

# 169-865H-31R-1

169-856H-31R-1

Top of Section 31R-1 - 201.00 mbsf

## Pieces 1-18

**ROCK TYPE: SULFIDE-BANDED SANDSTONE**

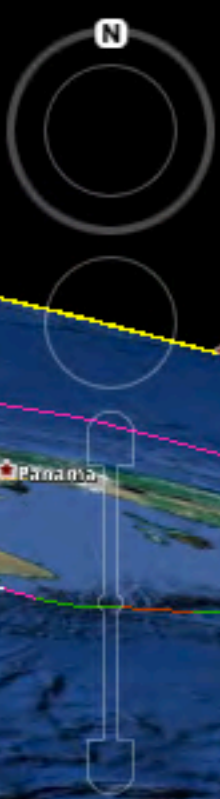
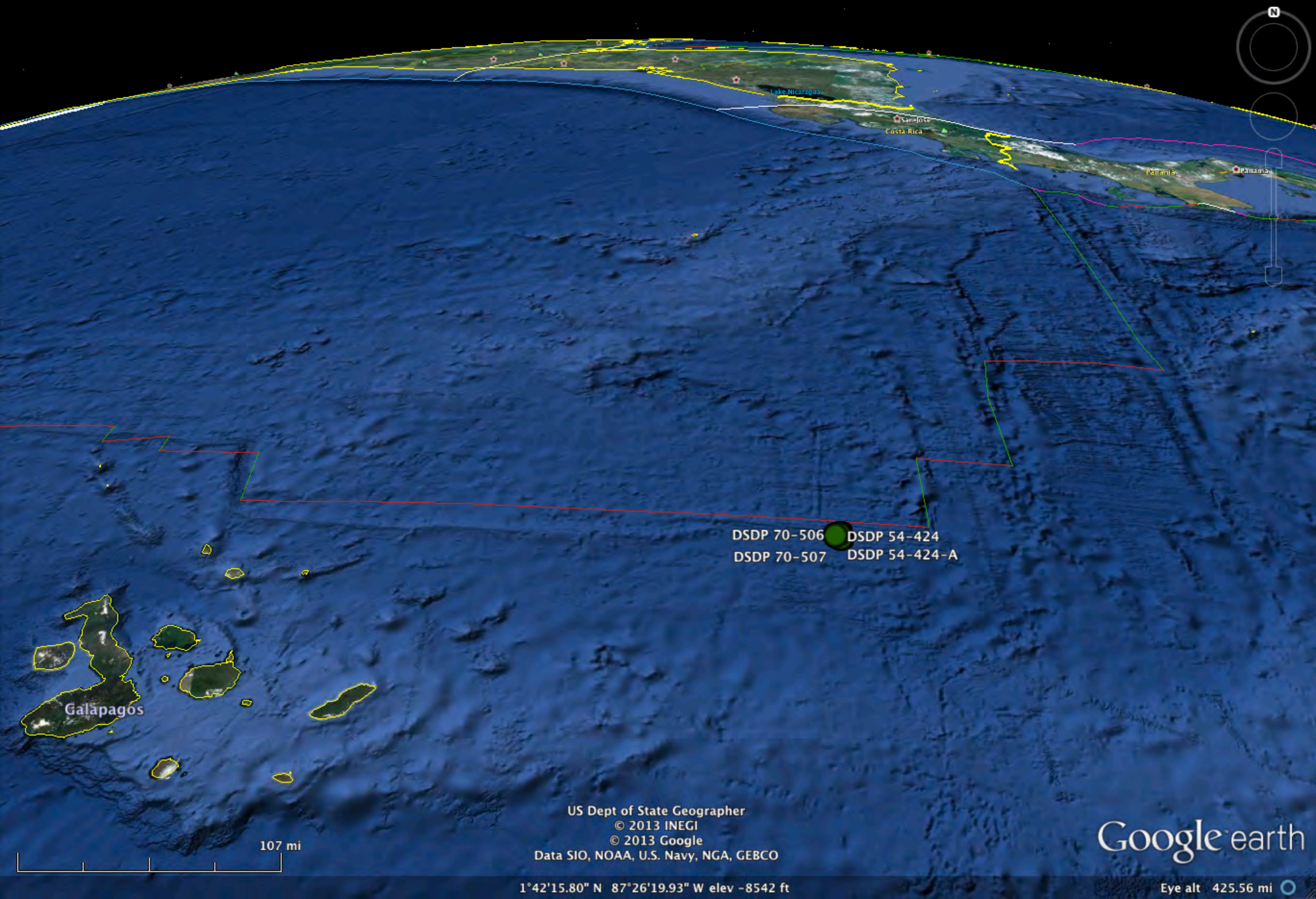
**COLOR:** Gray, striped with bronze and brassy yellow

**HOST ROCK:**

Partially to almost completely replaced turbiditic sequence (A-C). Sandy layers are preferentially replaced by pyrite with minor chalcopyrite  $\pm$  pyrrhotite. Sulfides replace sedimentary structures such as beds, burrows, etc. Also seen are cross laminated layers replaced by pyrite (Pieces 5 and 13). Ripple laminations are seen in Pieces 12, 14, and 17. Piece 6 is texturally different. It consists of round white spots that have a radial structure (soft mineral--Mg smectite?); sulfide appear to fill space between these structures. Both minerals are hydrothermal/recrystallized possibly from a fine-grained clay-rich protolith(?). Some sulfides appear to be infiltrating into the radial structures. Piece 7 is also similar but on a coarser scale. The silicate blebs do not show the radial texture in all places.

**SULFIDE %:** 30 -75, high





DSDP 70-506 DSDP 54-424  
DSDP 70-507 DSDP 54-424-A

Galapagos

107 mi

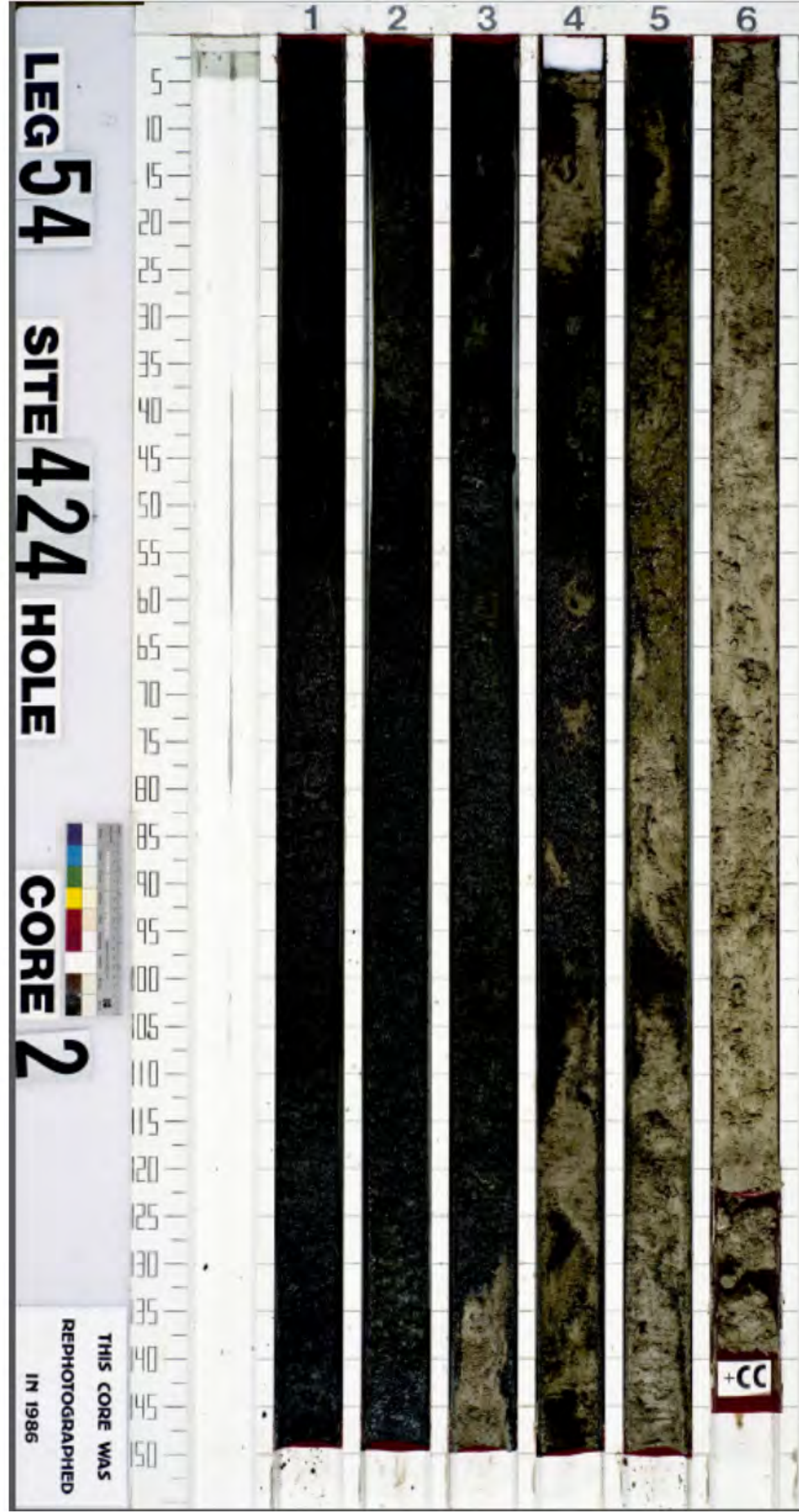
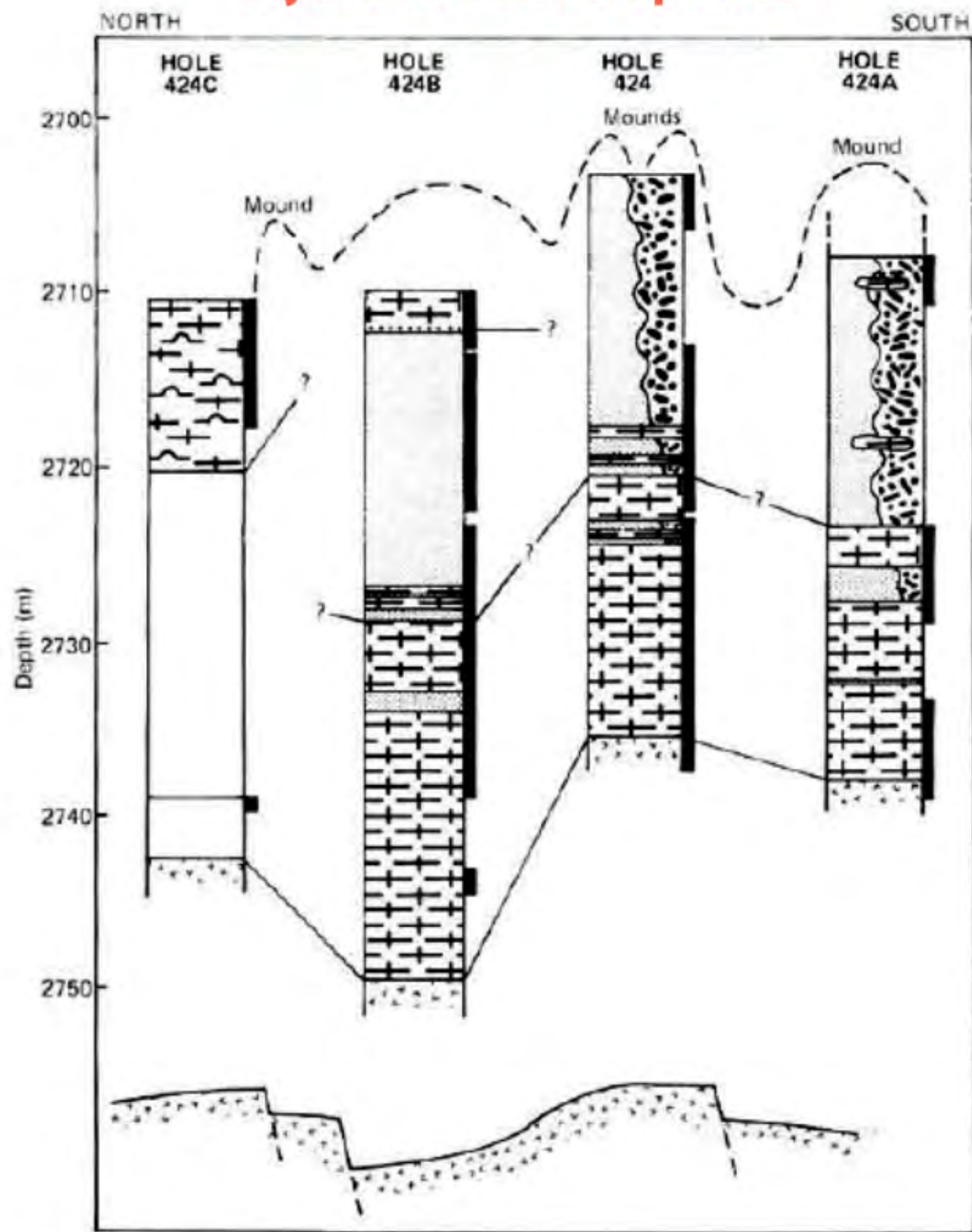
US Dept of State Geographer  
© 2013 INEGI  
© 2013 Google  
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google earth

1°42'15.80" N 87°26'19.93" W elev -8542 ft

Eye alt 425.56 mi

# DSDP Leg 54, Site 424 Hydrothermal Deposits



# DSDP Leg 70 Hydrothermal Mounds

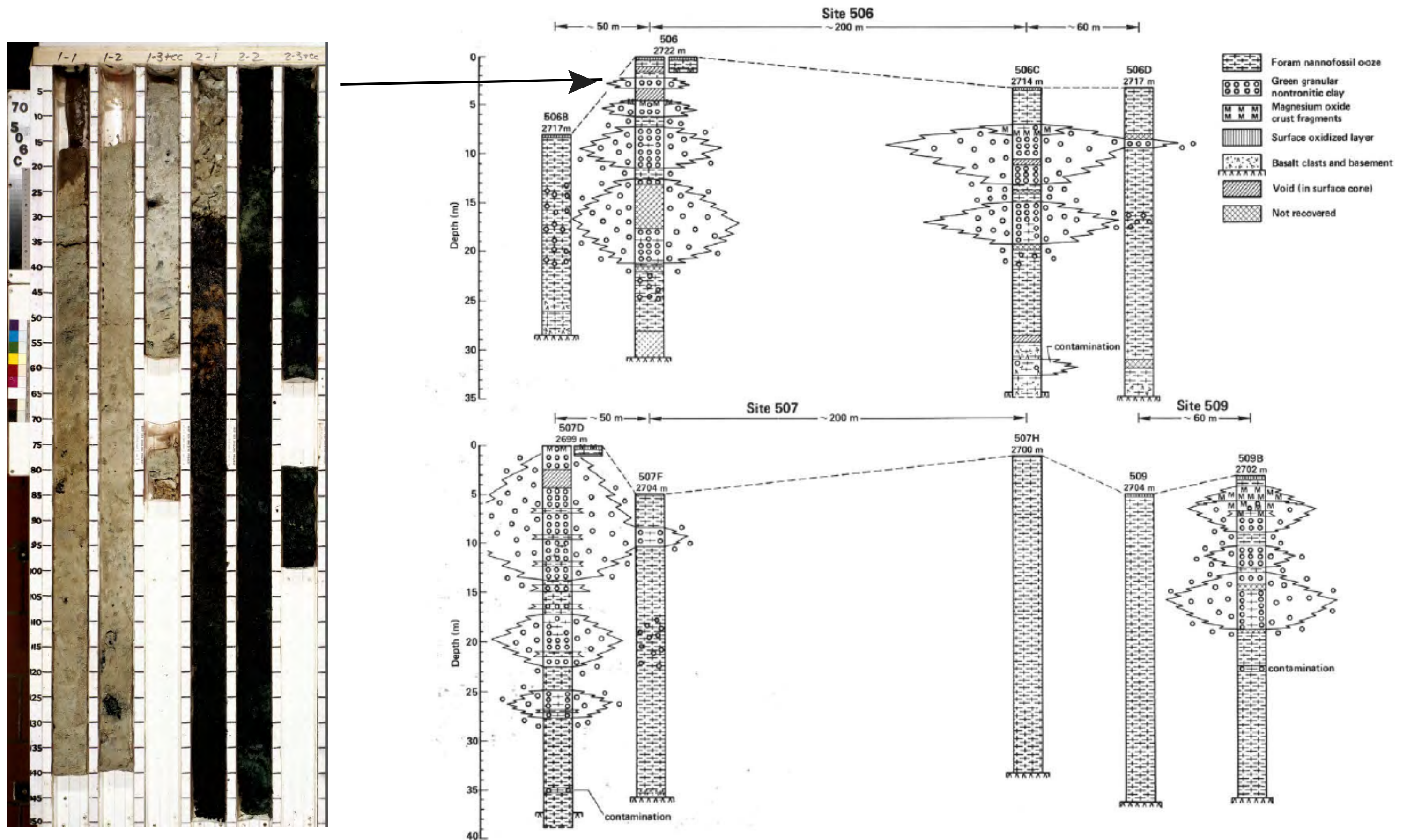


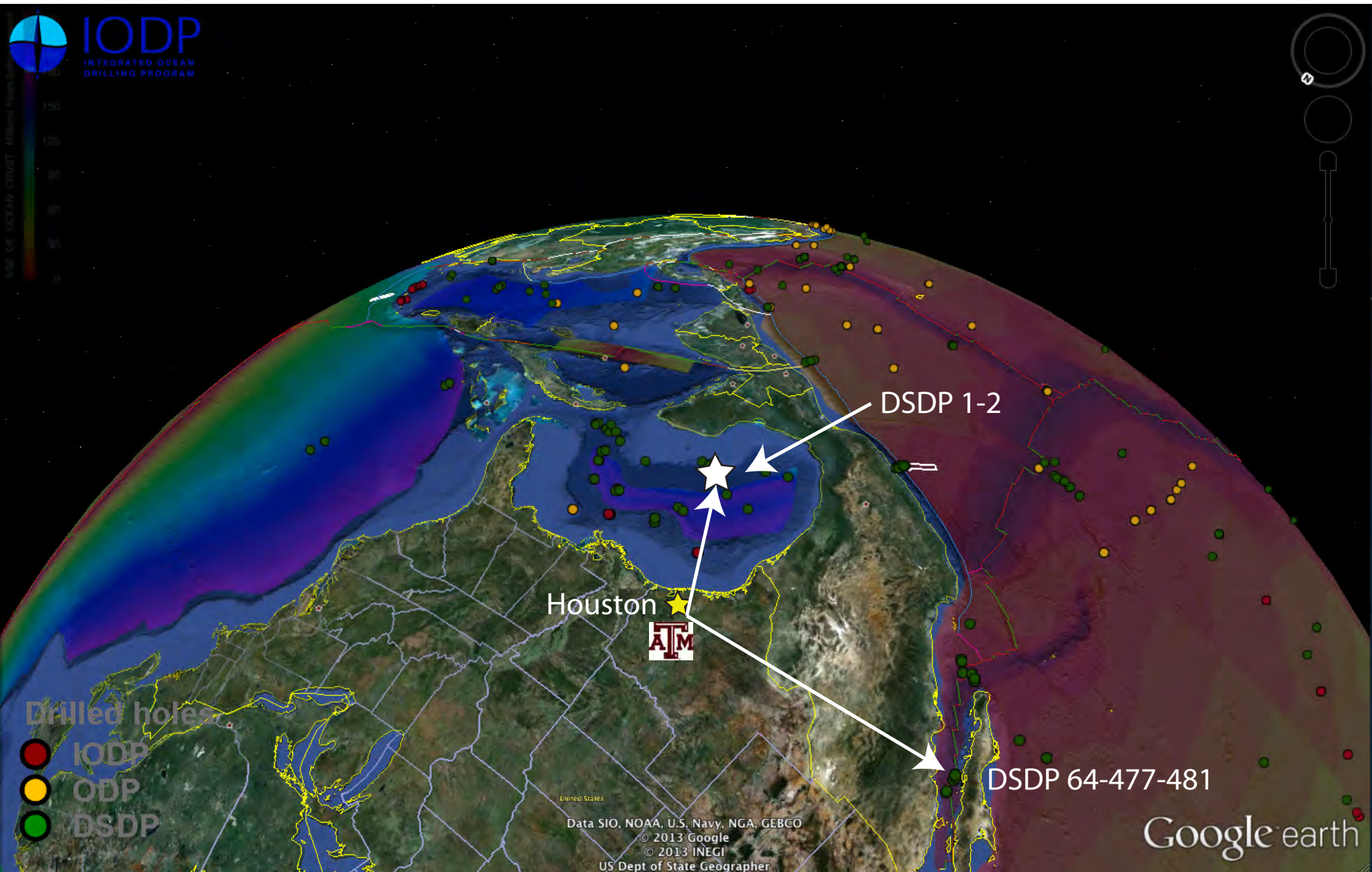
Figure 7. Stratigraphic relationships among and between mounds sediments.

from Borella, PE., 1983. In: Honnorez, J., Von Herzen, R.P. et al., Init. Repts. DSDP, 70. Washington (U.S. Govt. Printing Office), p. 190.

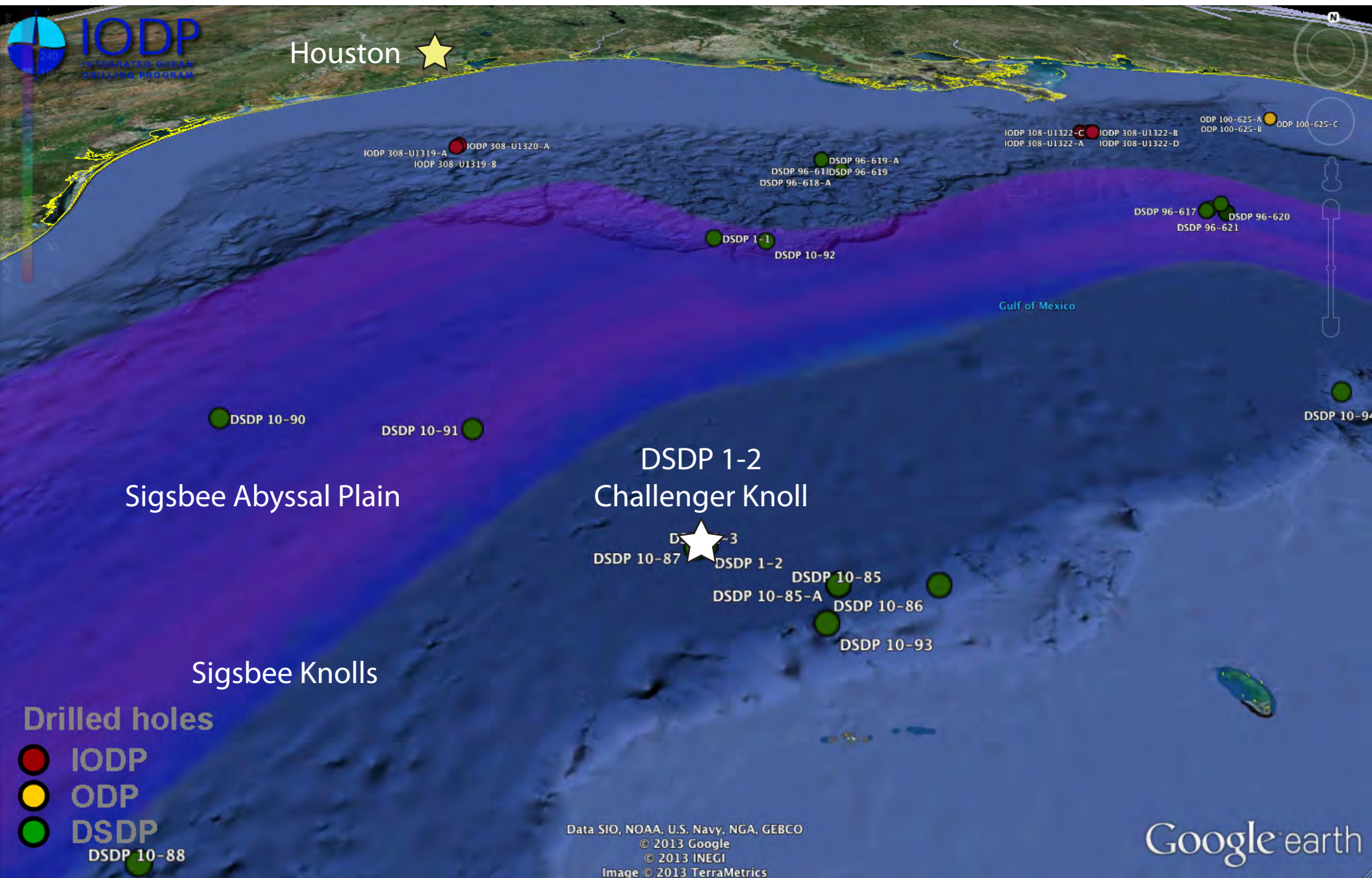
## Petroleum in GCR Cores

| Leg | Site | Region/Feature                    |
|-----|------|-----------------------------------|
| 1   | 2    | Sigsbee Knolls, Gulf of Mexico    |
| 64  | 477  | Guaymas Basin, Gulf of California |
|     | 478  | Guaymas Basin, Gulf of California |
|     | 481  | Guaymas Basin, Gulf of California |
| 169 | 858  | Middle Valley, Juan de Fuca Ridge |
|     | 1036 | Middle Valley, Juan de Fuca Ridge |
|     | 1037 | Escanaba Trough, Gorda Ridge      |
|     | 1038 | Escanaba Trough, Gorda Ridge      |

# Petroleum in GCR Cores: A "Texan's Eye View"



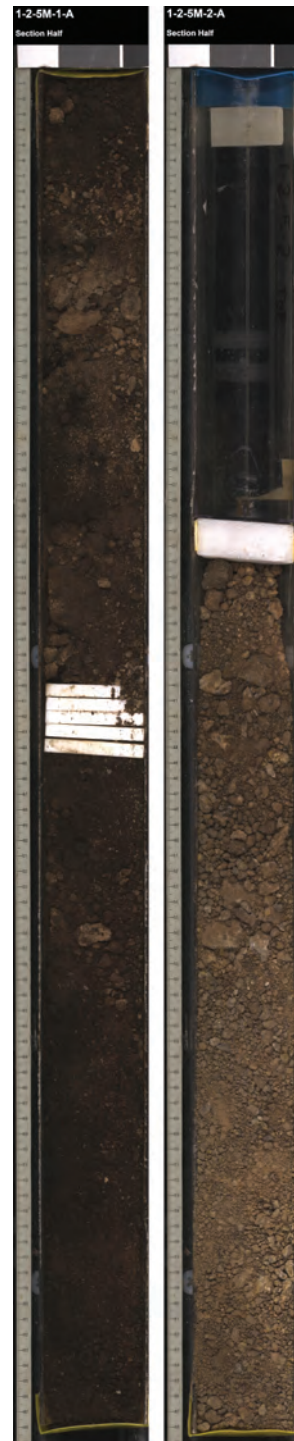
# Petroleum in GCR Cores: Leg 1 Site 2 Challenger Knoll



Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
© 2013 Google  
© 2013 INEGI  
Image © 2013 TerraMetrics

Google earth





DSDP Site 2, Core 5 -  
Gypsum/Halite with  
petroleum

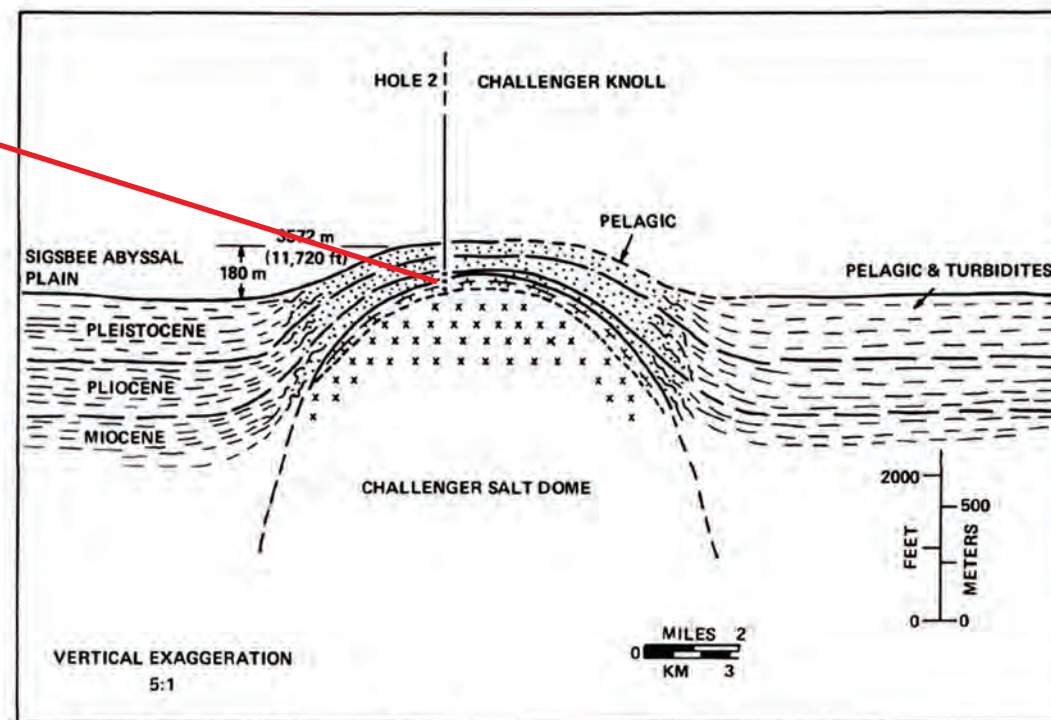


Figure 26. Structure section of Challenger Knoll.

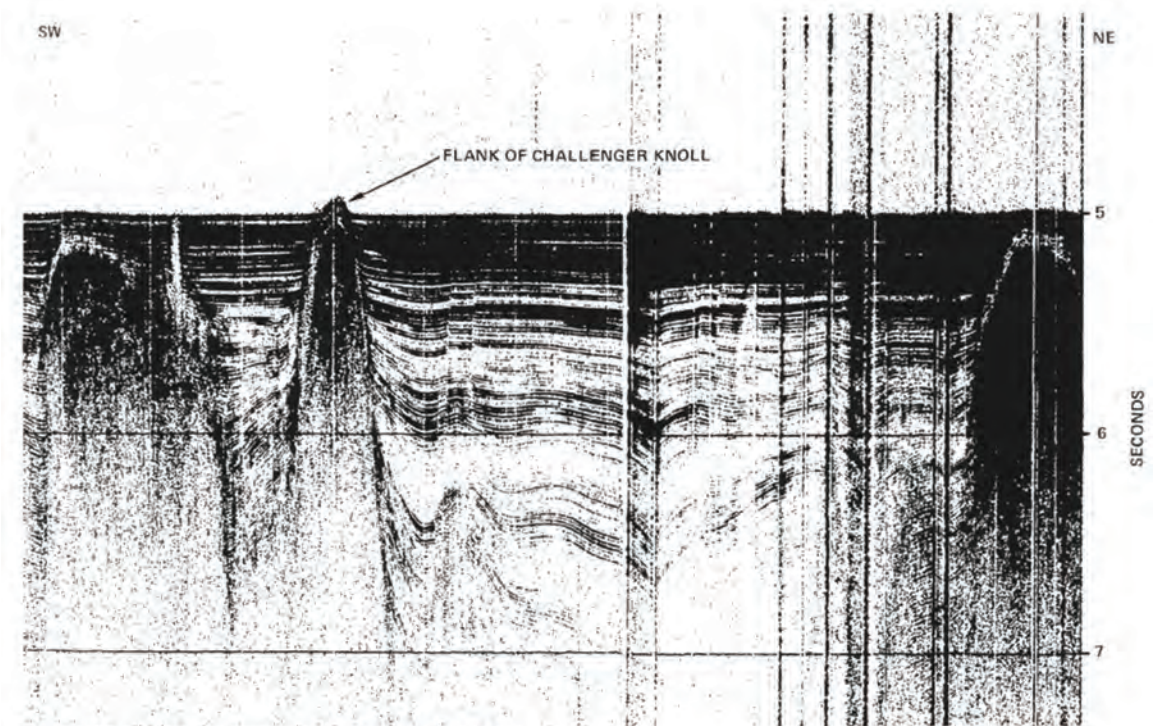


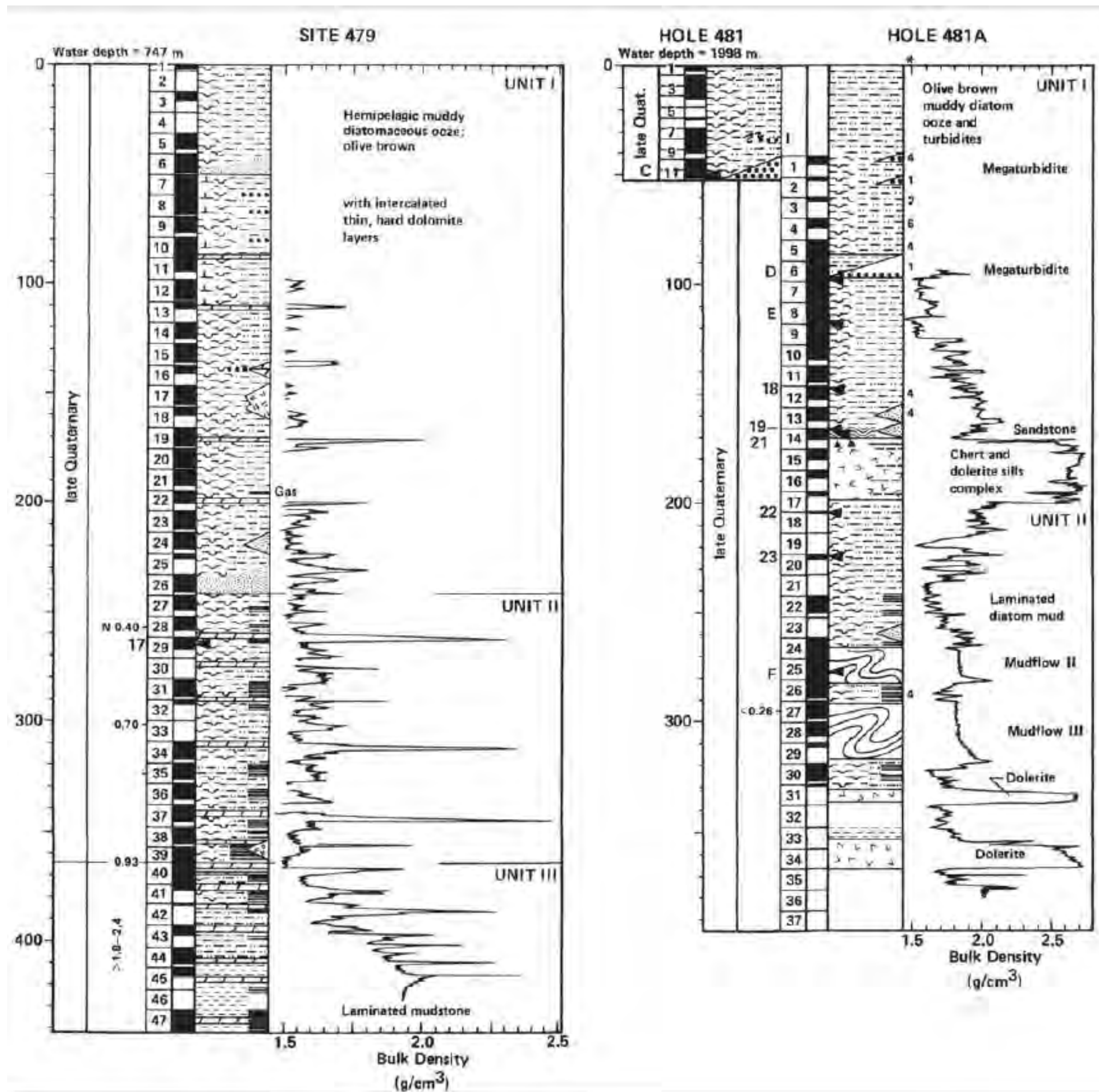
Figure 27. Profiler traverse of Challenger Knoll area.

Shipboard Scientific Party, 1969. Site 2. In: Ewing, M., Worzel, J.L., et al., Initial Reports of the Deep Sea Drilling Project, 1. Washington (U.S. Govt. Printing Office). doi:10.2973/dsdp.proc.1.102.1969

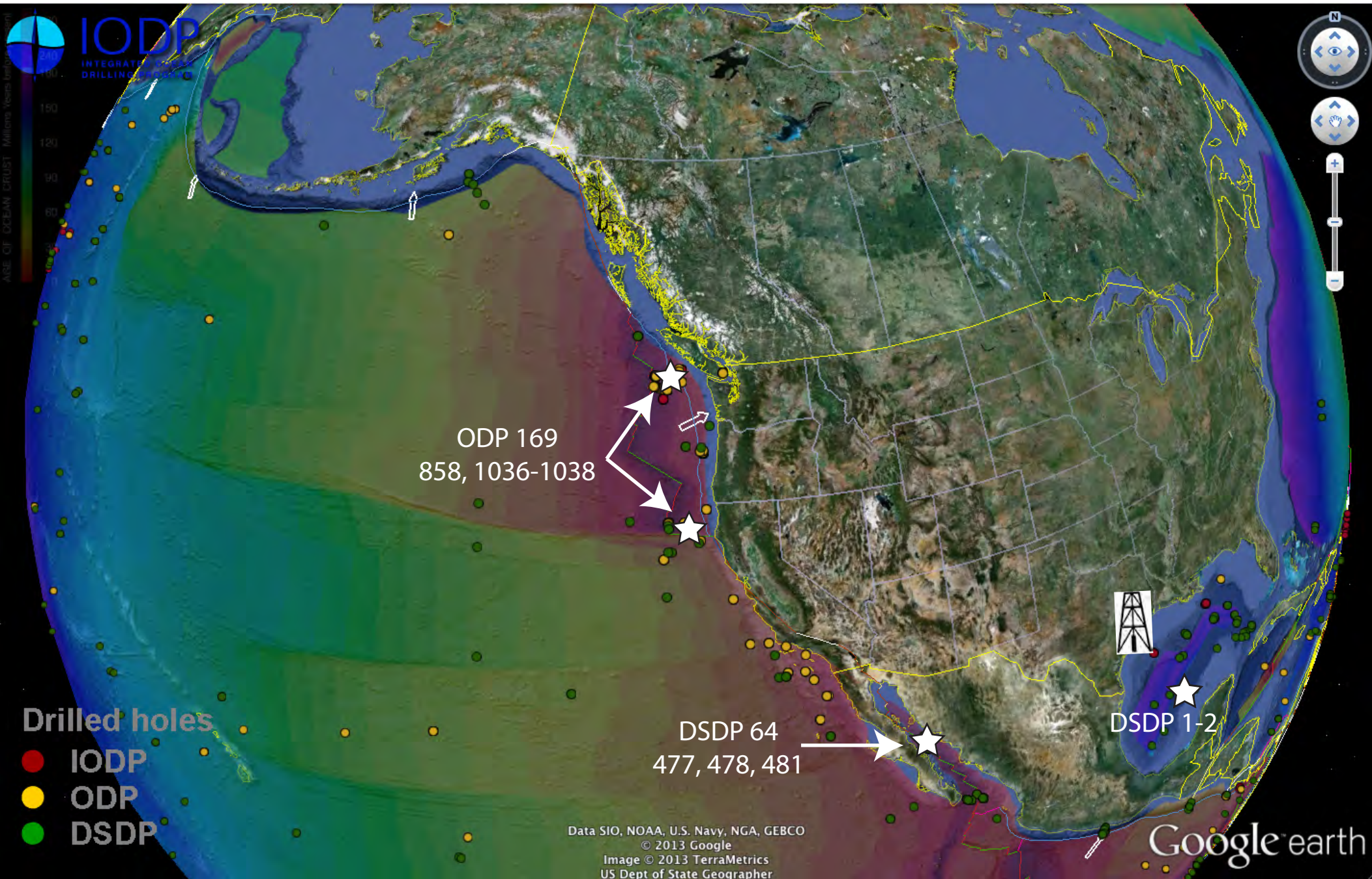
# Petroleum in GCR Cores: DSDP Leg 64 Guaymas Basin, Gulf of California



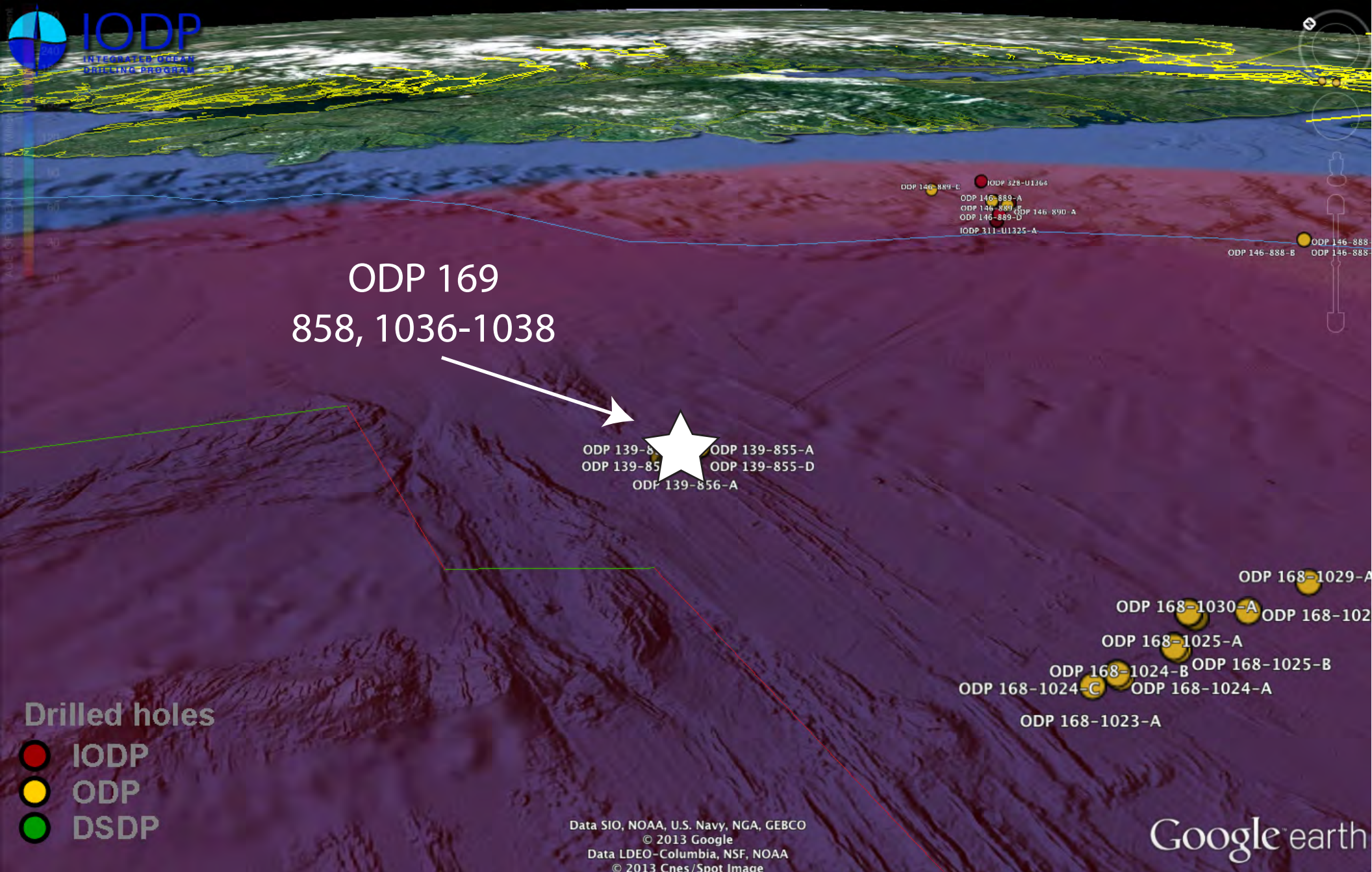
Petroleum-bearing mudstone



# Petroleum in GCR Cores: DSDP Leg 1, 64 and ODP Leg 169



# Petroleum in GCR Cores: ODP Leg 169 Site 858 & 1036-1038



Sections 139-858B-1H-1  
and -2H-3: petroleum-bearing  
muds from Middle Valley,  
Juan De Fuca Ridge

