GOBIERNO DE ESPAÑA | MINISTERIO DE CIENCIA E INNOVACIÓN | Instituto Geológico y Minero de España

From BATDRAKE to CENTRAL SCOTIA SEA

Bohoyo, F., Larter, R.D., Galindo-Zaldívar, J., Leat, P.T., Maldonado, A., Tate, A.J., Gowland, E.J.M., Arndt, J.E., Dorschel, B., Kim, Y.D., Hong J.K., Flexas M.; López-Martínez, J., Maestro, A., Bermudez, O., Nitsche, F.O., Livermore, R. A. and Riley, T. R.

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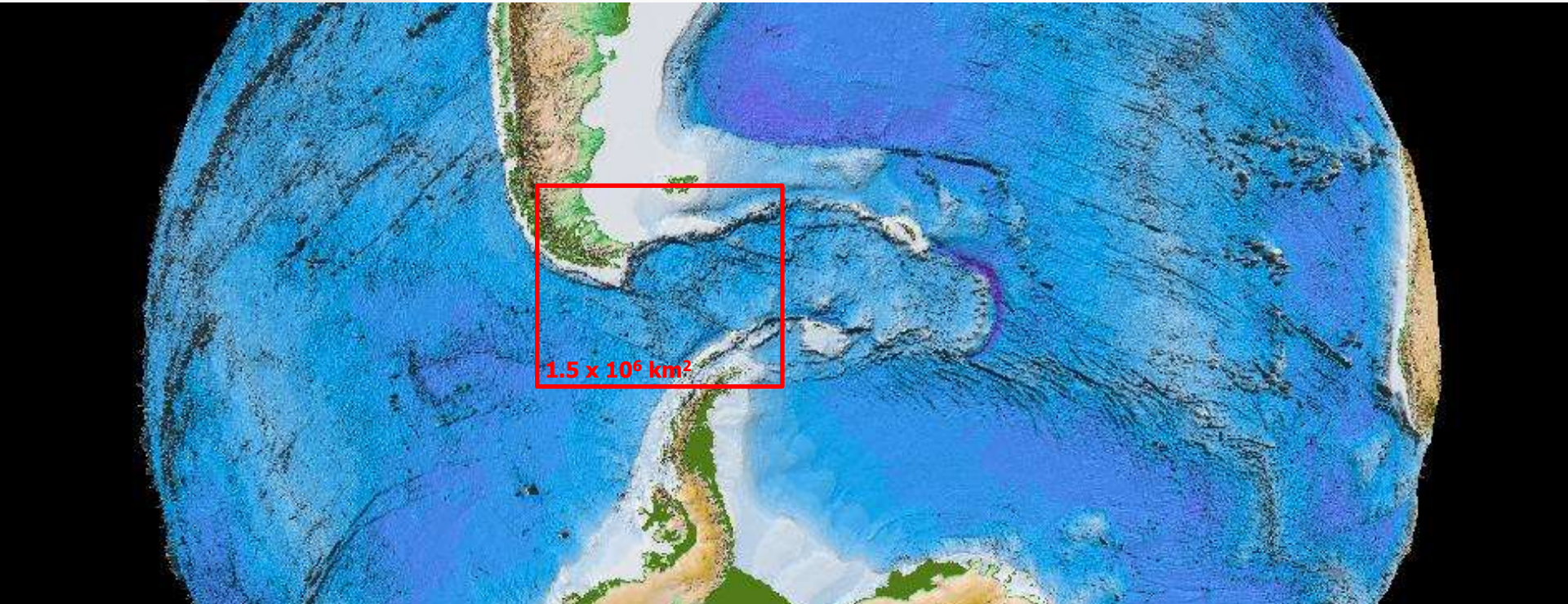
British Antarctic Survey – NATURAL ENVIRONMENT RESEARCH COUNCIL
AWI
KOPRI – Korea Polar Research Institute
CSIC
IMEDEA
UNIVERSIDAD AUTÓNOMA DE MADRID
Lamont-Doherty Earth Observatory – Columbia University | Earth Institute

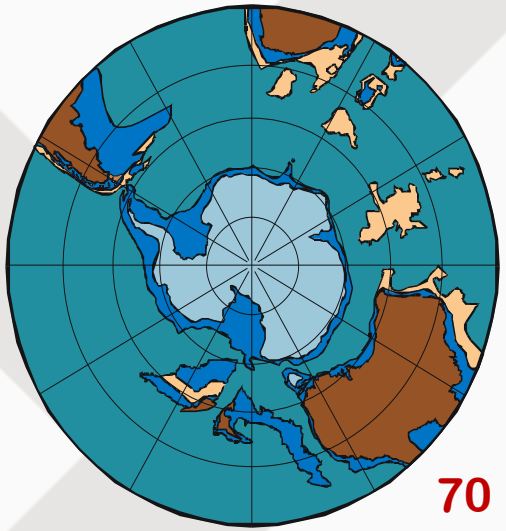
WHAT IS BATDRAKE ?

This project constitute an international cooperative effort coordinated by the **Spanish Geological Survey (IGME)** and the **British Antarctic Survey (BAS)**, together to the **Korea Polar Research Institute (KOPRI)**, the **Alfred Wegener Institute (AWI)** and other Spanish Research Institutions, for the compilation of precise bathymetric data obtained on previous and future cruises in the **Drake Passage** region (54ºS-62.5ºS and 70 ºW-52 ºW)

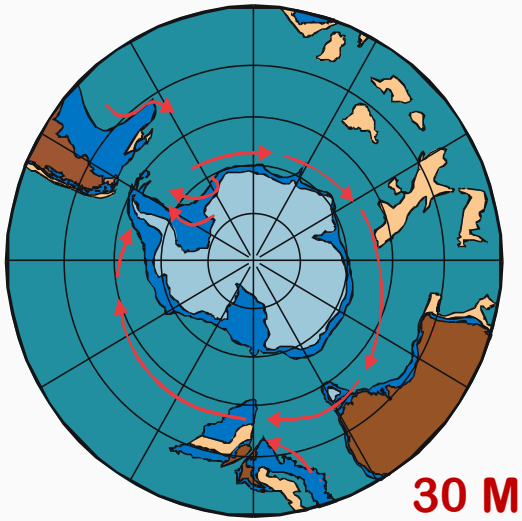


WHY THE DRAKE PASSAGE REGION ?

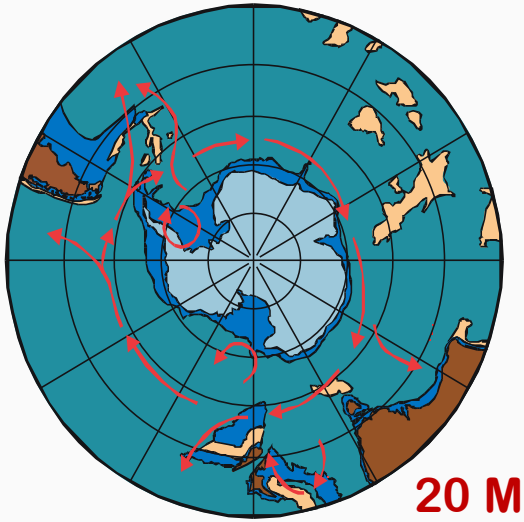
The opening of the main southern oceanic gateways, mainly **Drake Passage** and the **Tasman Strait**, permitted the modern pattern of global ocean circulation to be established. This allowed extensive exchange of water between the main ocean basins and led to the development of the **Antarctic Circumpolar Current (ACC),** which caused the thermal isolation of Antarctica, and was partially responsible for global cooling at the Eocene-Oligocene boundary.



70 Ma



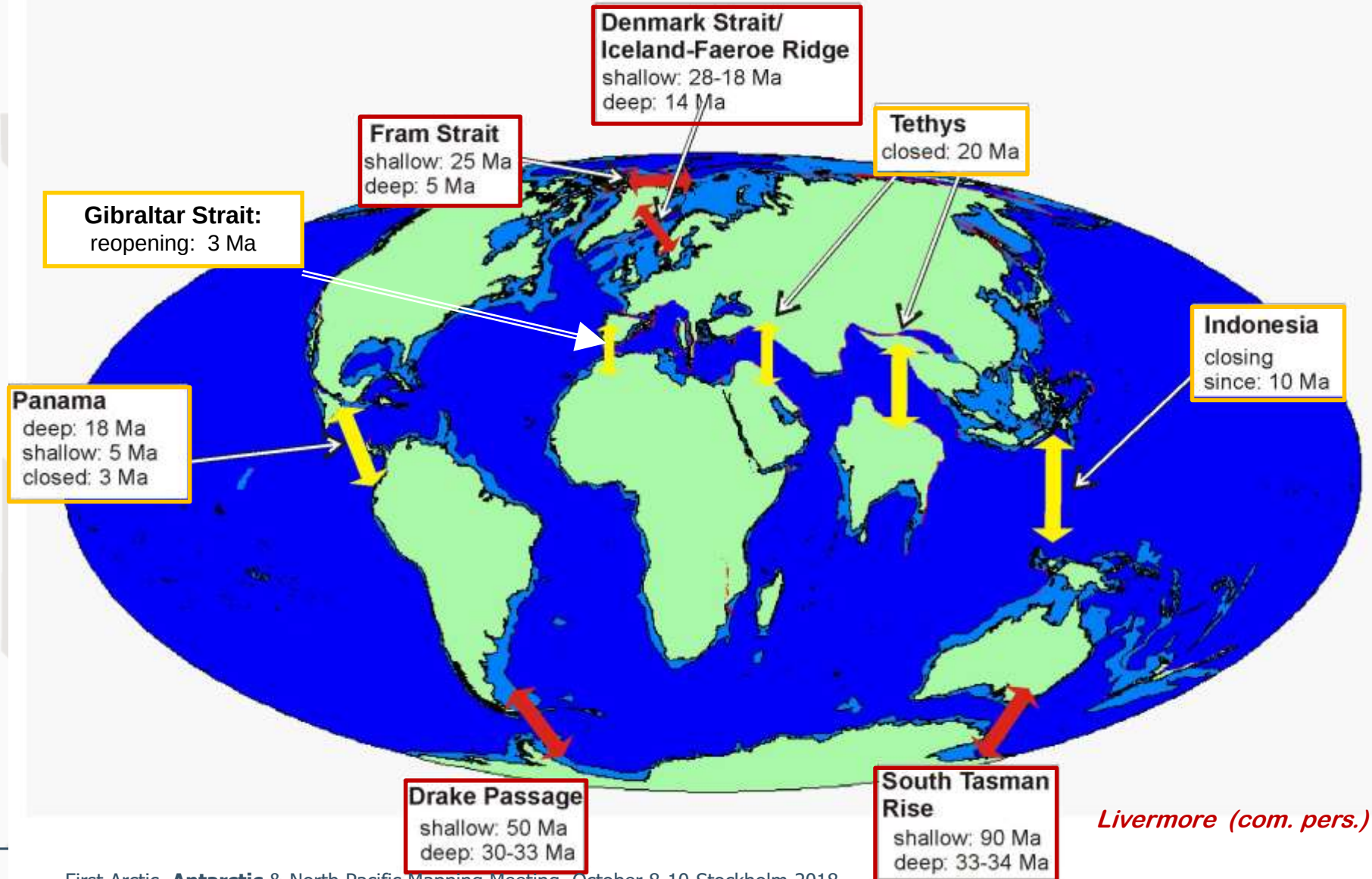
30 Ma



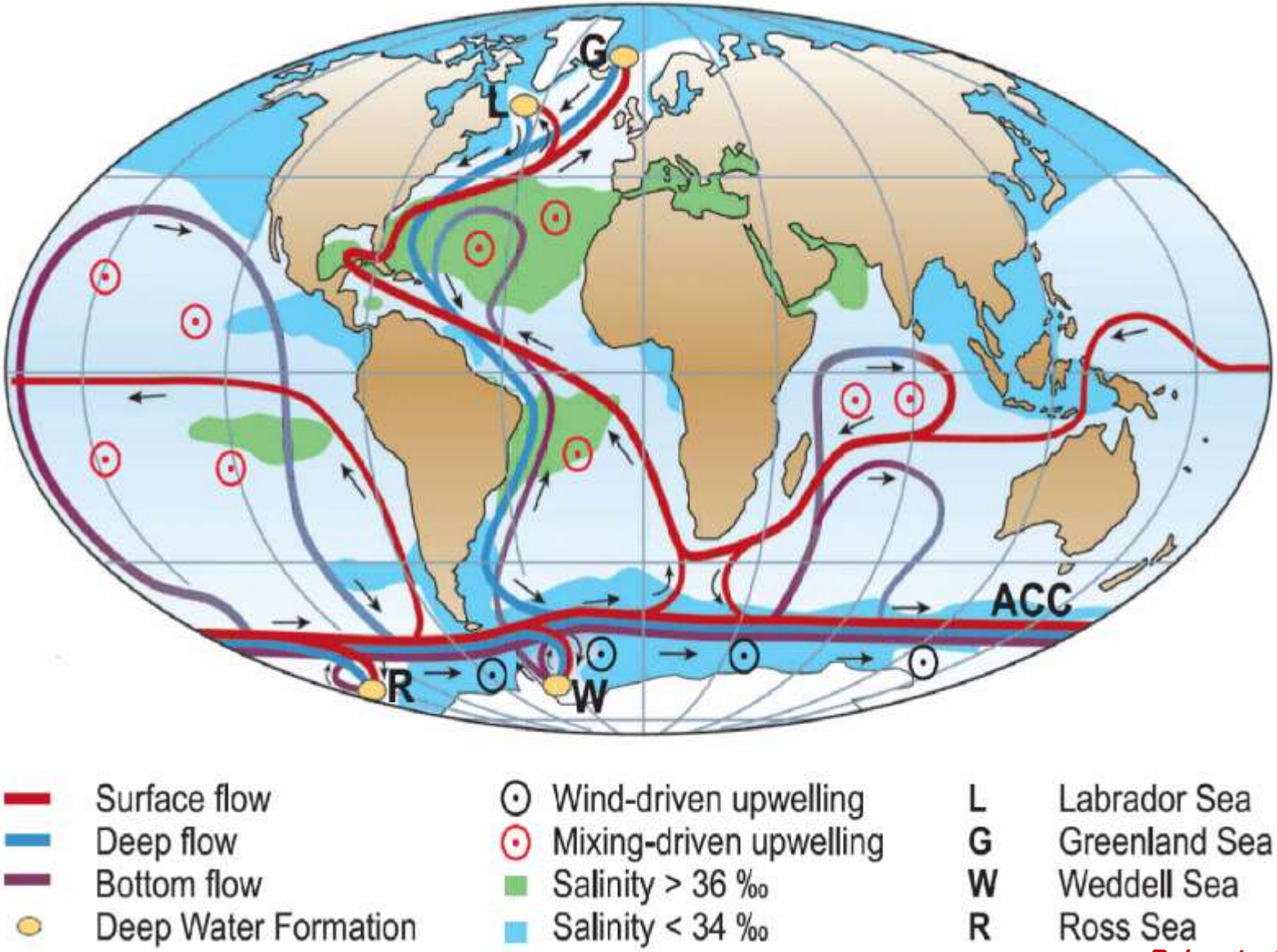
20 Ma

Maldonado, 2002

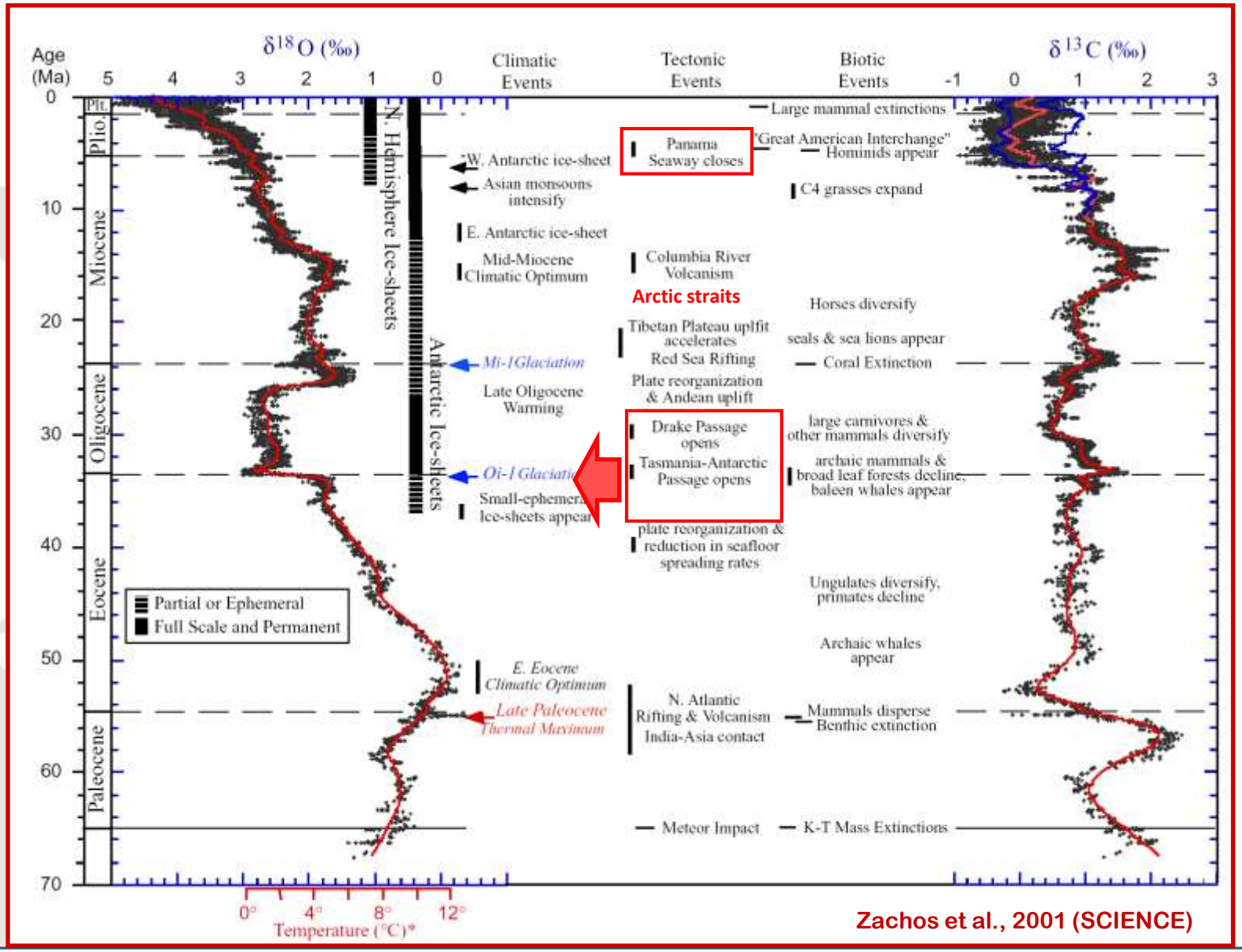
Ocean Gateways



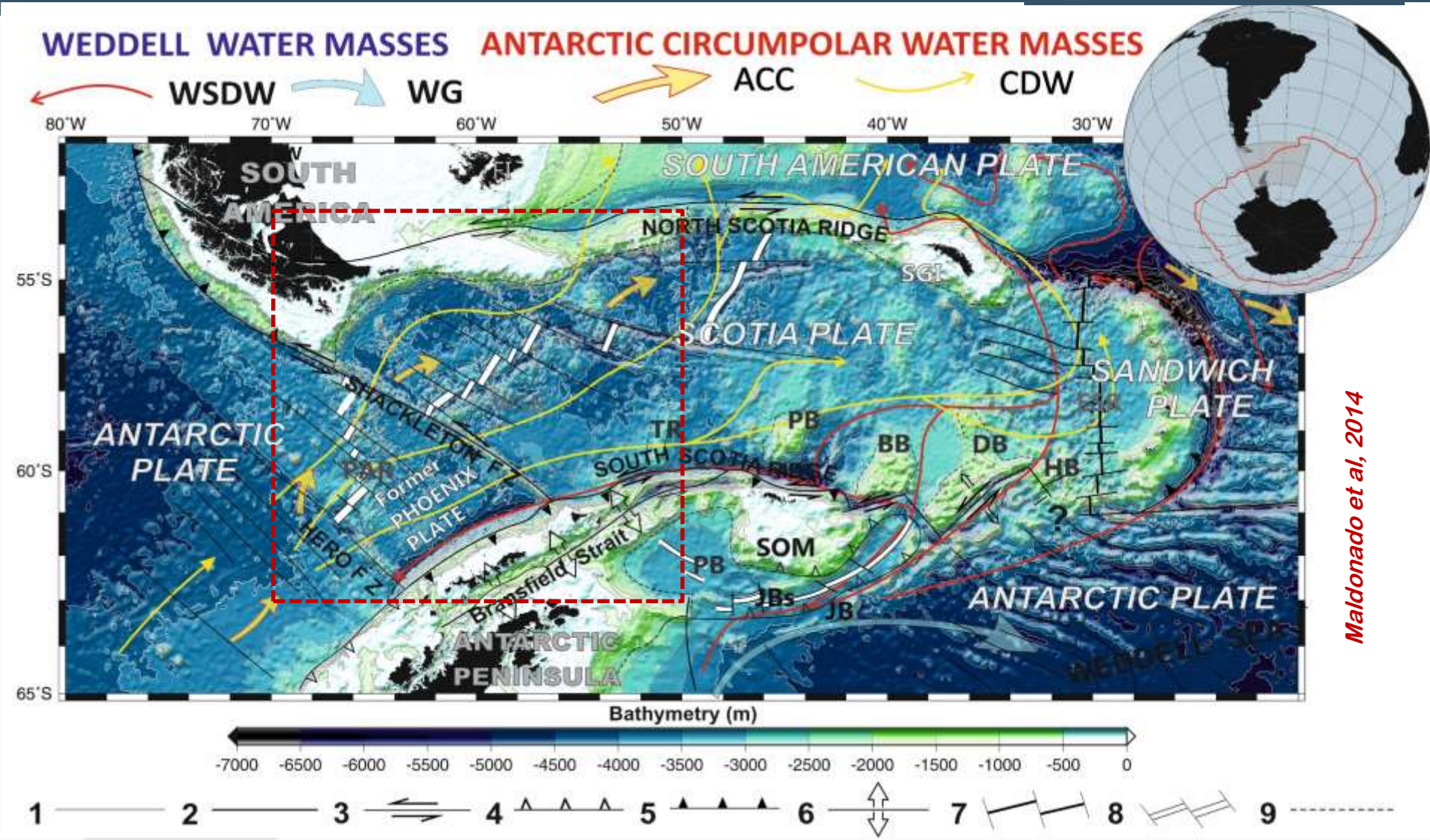
Livermore (com. pers.)



Rahmstorf (Nature 2002)



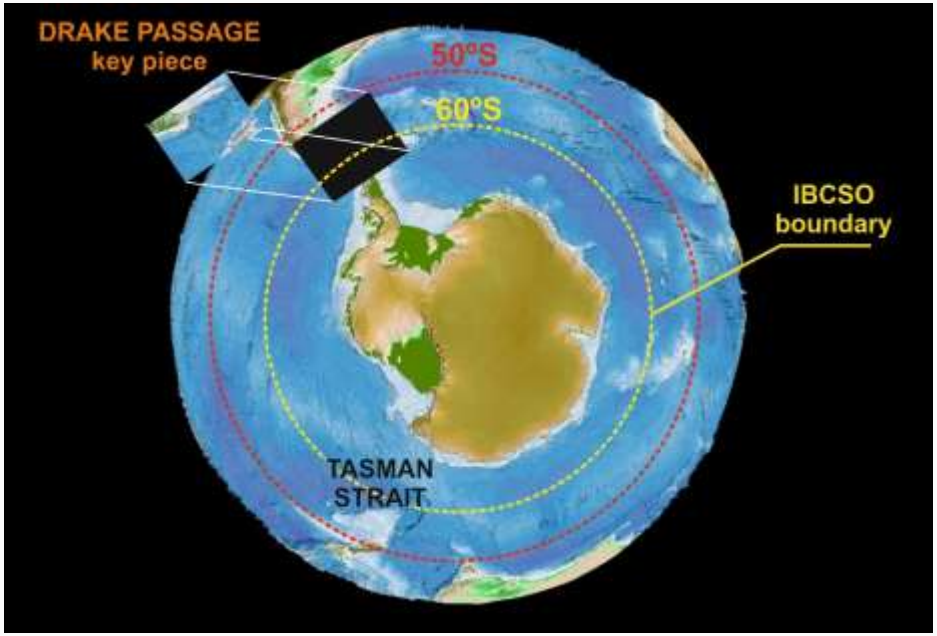
Zachos et al., 2001 (SCIENCE)



Maldonado et al, 2014

Main oceanic currents scheme and Drake Passage interactions

This initiative is part of **IBCSO (International Bathymetric Chart of Southern Ocean)**, under the **SCAR** umbrella, which recognises the importance of regional data compilations in areas of particular scientific interest in the Antarctic, such as the Ross Sea, **Drake Passage** and the southern margin of Weddell Sea.



IBCSO 2.0 will focus to **Drake** and **Tasman** gateways extending to **50° S**.

International Bathymetric Chart of the Southern Ocean

DRAKE PASSAGE with GOOD WEATHER

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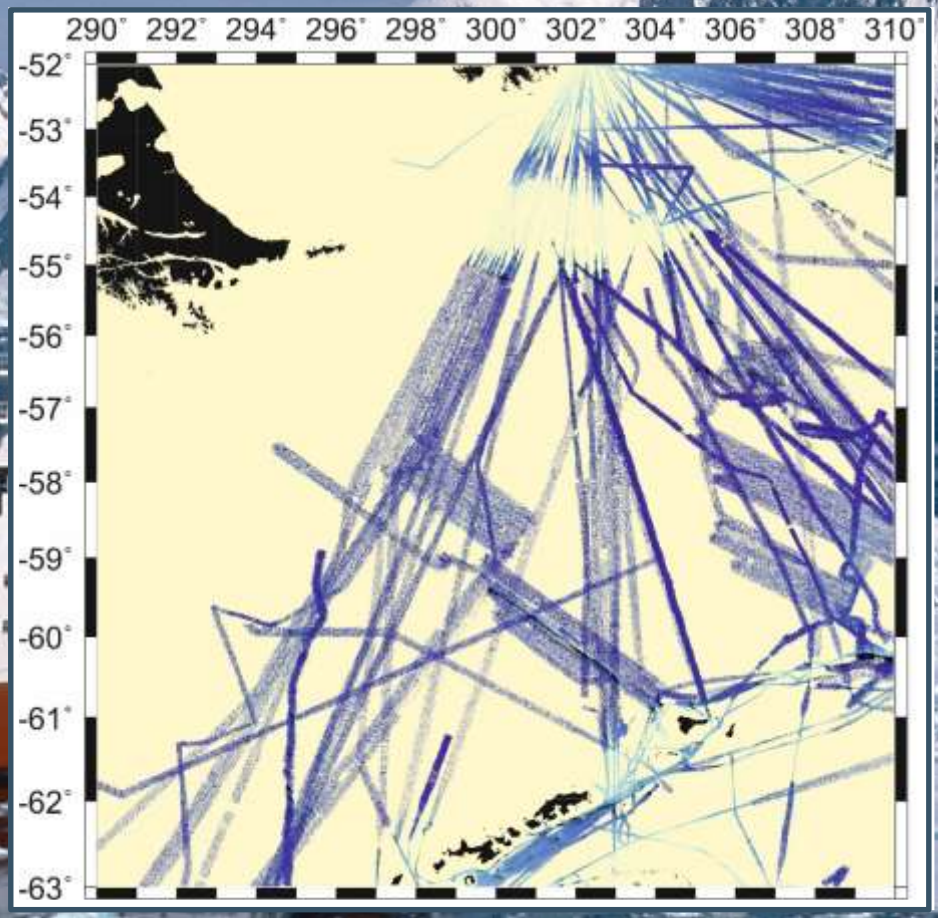
RRS JAMES CLARK ROSS

Multibeam system	Cruises
EM120 from 2000 to 2013 EM122 from 2013	56 cruises 89 transit lines 6 surveys

JR59	2001	JR114-121	2005	JR188	2009
JR60	2001	JR115	2004	JR193-196	2007
JR66	2001	JR116	2004	JR194-197	2008
JR69-67	2001	JR130	2004	JR206	2010
JR70	2002	JR130z	2004	JR224	2009
JR71	2002	JR134	2005	JR228	2009
JR72	2002	JR141	2006	JR230	2009
JR77-78	2004	JR149	2006	JR233	2009
JR81	2002	JR150	2006	JR239-235	2010
JR82	2003	JR151	2005	JR236	2010
JR84	2003	JR152-159	2006	JR240	2010
JR93	2003	JR157-166	2007	JR244	2011
JR93z	2003	JR158	2007	JR252-254C	2011
JR97	2005	JR165	2007	JR255A-B	2012
JR100	2004	JR168-167	2007	JR259	2012
JR103	2004	JR179	2008	JR275	2012
JR104	2004	JR184	2007	JR262-260A	2012
JR107	2004	JR185	2007	JR276	2011
JR109	2004	JR186	2008		
JR112	2005	JR187	2008		



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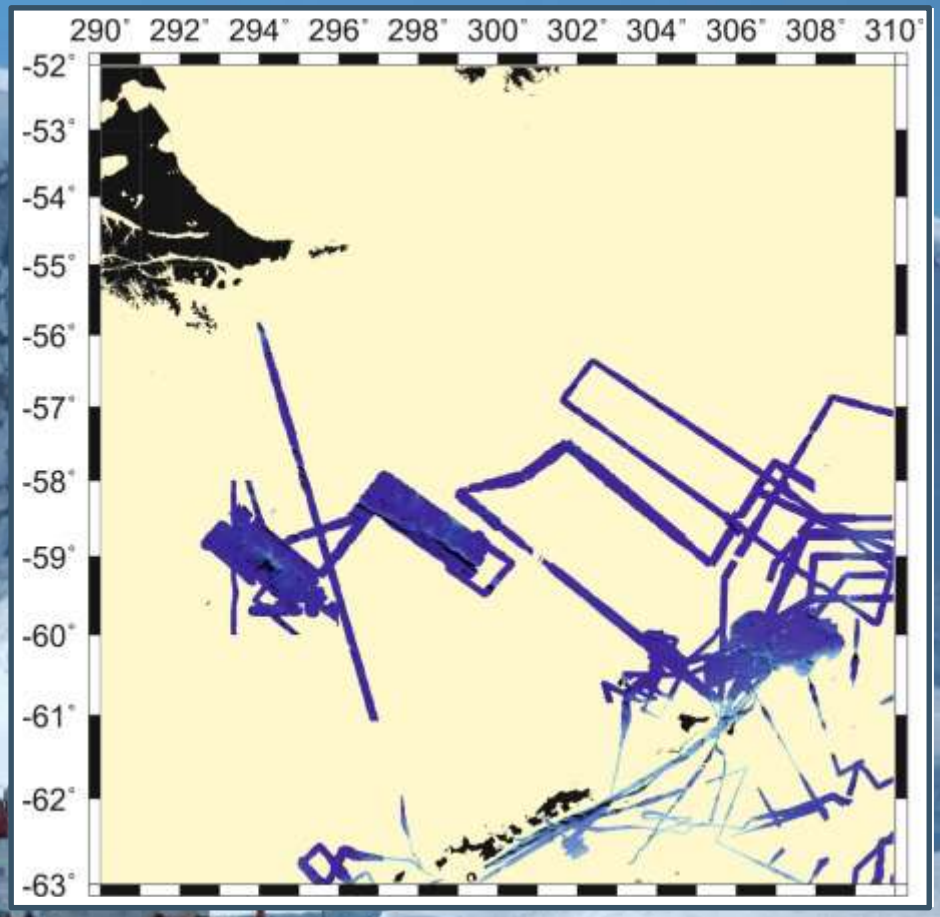
BIO HESPERIDES

Multibeam system	Cruises
EM12 from 1992 to 2004 EM120 from 2004	10 cruises MCS lines 5 surveys

HESANT9293	1993
SCAN97	1997
ANTPAC9798	1998
SCAN2001	2001
SCAN2004	2004
SCAN2008	2008
DRAKE2008	2008
ELEFANTE2012	2012
ELEFANTE2013	2013
SCAN2013	2013



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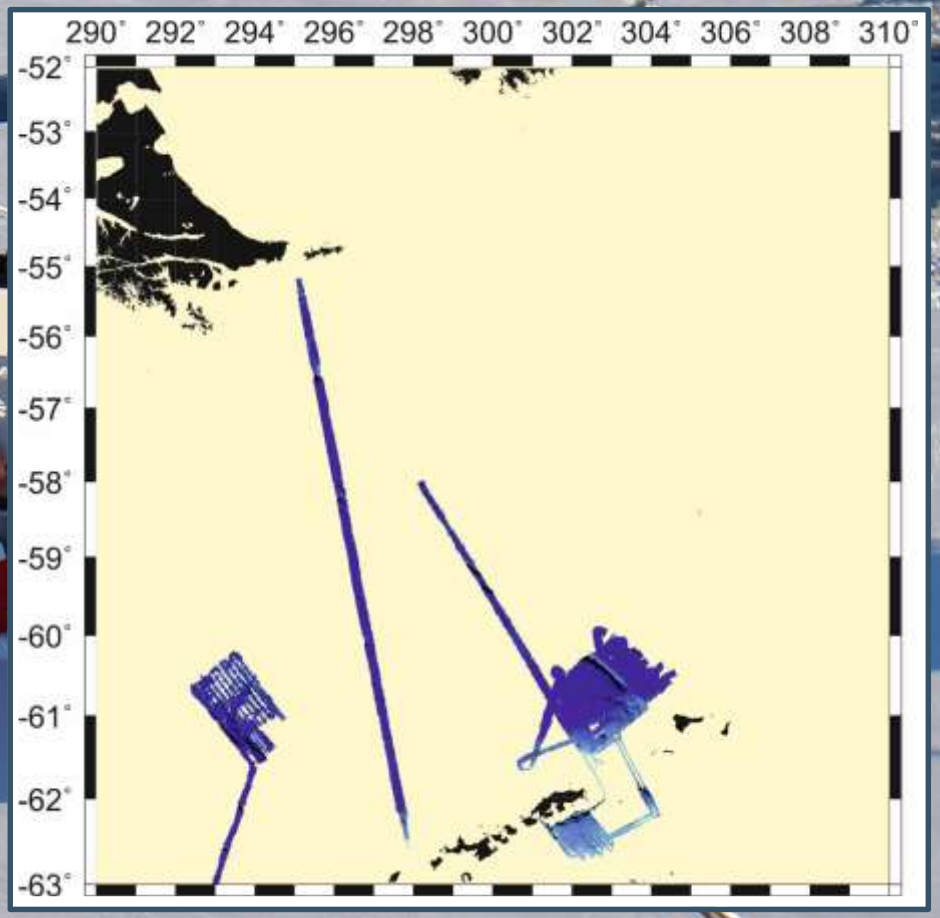
ARAON

Multibeam system	Cruises
EM120 from 2013	1 transit line

ONNURI

Multibeam system	Cruises
Seabeam 2000 from 1993 to 1999	2 cruises 2 surveys

KOREA93	1993
KOREA99	1999
KOREA2013	2013



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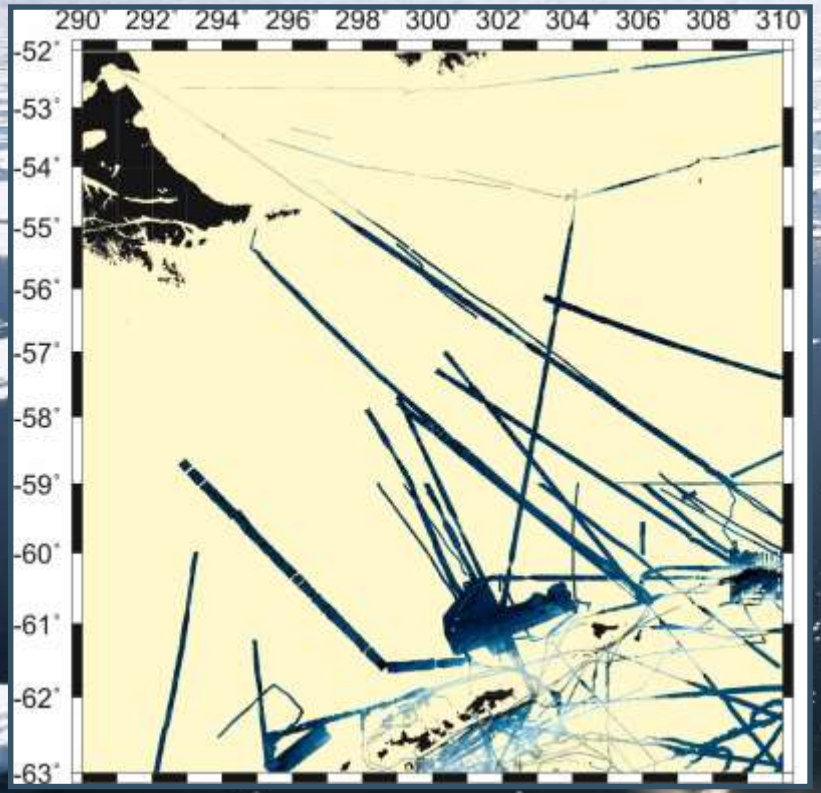
POLASTERN

Multibeam system	Cruises
SeaBeam from 1986 Hydrosweep DS-1 from 1990 Hydrosweep DS-2 from 2000	29 cruises



ANT-IV/4	1986
ANT-V/4	1987
ANT-VI/2	1987
ANT-VI/3	1987
ANT-VIII/4	1989
ANT-VIII/5	1989
ANT-IX/2	1990
ANT-XI/3	1994
ANT-XII/3	1995
ANT-XV/2	1997
ANT-XV/4	1998
ANT-XVII/3	2000
ANT-XVIII/4	2001
ANT-XVIII/5a	2001
ANT-XIX/5	2002

ANT-XX/2	2002
ANT-XXII/2	2004
ANT-XXII/3	2005
ANT-XXII/4	2005
ANT-XXIII/4	2006
ANT-XXIII/7	2006
ANT-XXIII/8	2006
ANT-XXIII/9	2007
ANT-XXVII/3	2011
GAP95	1995
GAP98	1998
ANT-XIX/4	2002
ANT-XXIII/5	2006
ANT-XXIX/3	2013

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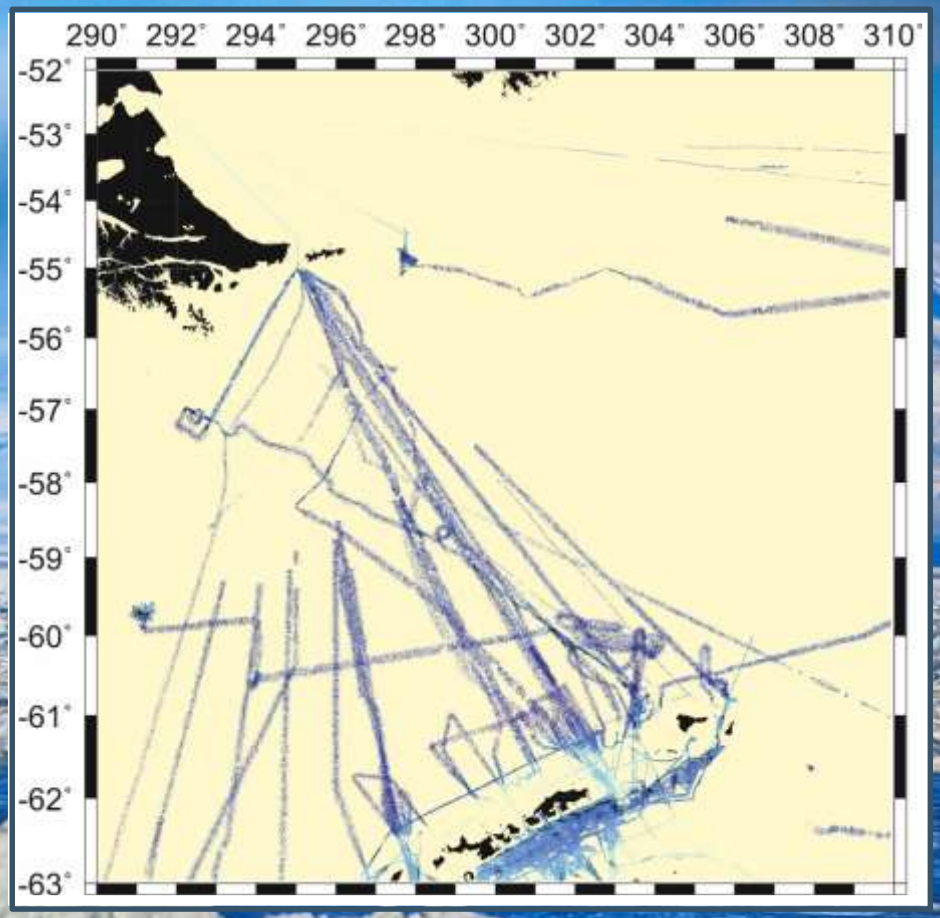
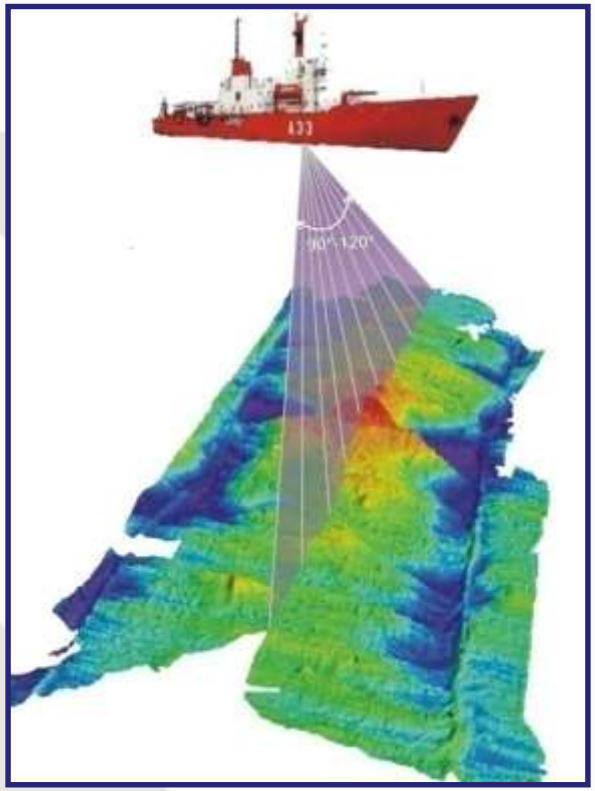
NATHANIEL B PALMER

Multibeam system	Cruises
EM120 from 2002 SeaBeam 2112 from 1995 to 2002	19 cruises

AMLR95	1995
NBP9507	1995
NBP9902	1999
NBP9903	1999
NBP9904	1999
NBP9905	1999
NBP0001	2000
NBP0002	2000
NBP0003	2000
NBP0103	2001
NBP0104	2001
NBP0107	2001
NBP0201	2002
NBP0202	2002
NBP0502	2005
NBP0506	2005
NBP0602A	2006
NBP0703	2007
NBP0805	2008



Most of data comes from similar system



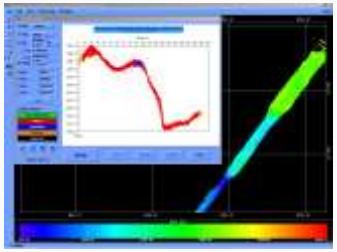
SIMRAD		EM12	EM120	EM122
Beams		81	191	288
Coverage Angle		90º	120º (max 150º)	140º (max 150º)
Coverage		2*Depth	3.5*Depth	5*Depth (2-6)
Depth 1000 m	Swath width Cell resolution	2000 m ~25 m	3500 m ~20 m	5000 m ~18 m
Depth 3000 m	Swath width Cell resolution	6000 m ~75 m	10500 m ~55 m	15000 m ~52 m
Depth 5000 m	Swath width Cell resolution	10000 m ~125 m	17500 m ~95 m	25000 m ~86 m
Depth 6000 m	Swath width Cell resolution	12000 m ~150 m	21000 m ~110 m	30000 m (max) ~105 m

BATDRAKE cell resolution 200 m, although 100 m will be an alternative

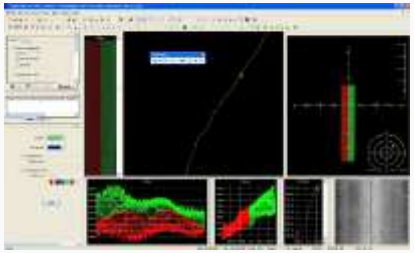
RAW DATA

DATA CLEANING

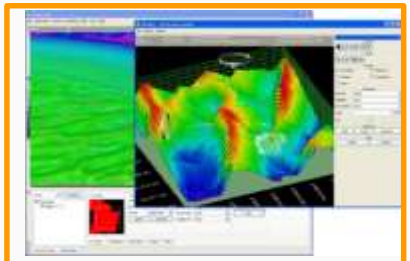
MB SYSTEM



NEPTUNE KONGSBERG



caris



FLEDERMAUS

CLEAN XYZ DATA

RnR

GRIDDING & IMAGERY

IBCSO
GEBCO14

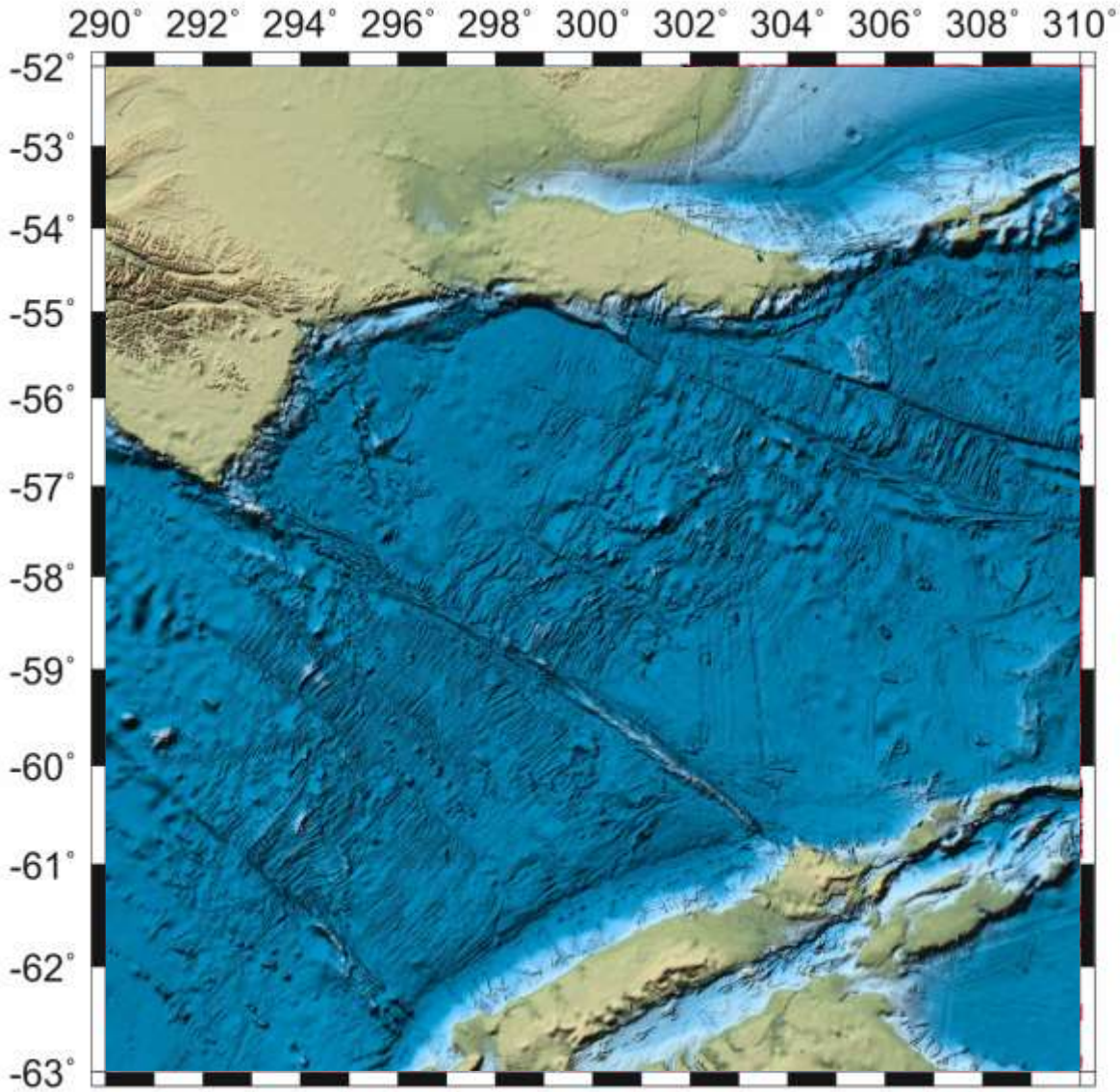
Global Mapper — GLOBAL MAPPER

QPS — FLEDERMAUS

GMT — THE GENERIC MAPPING TOOLS

esri — ArcGIS

GRIDs and MAPs



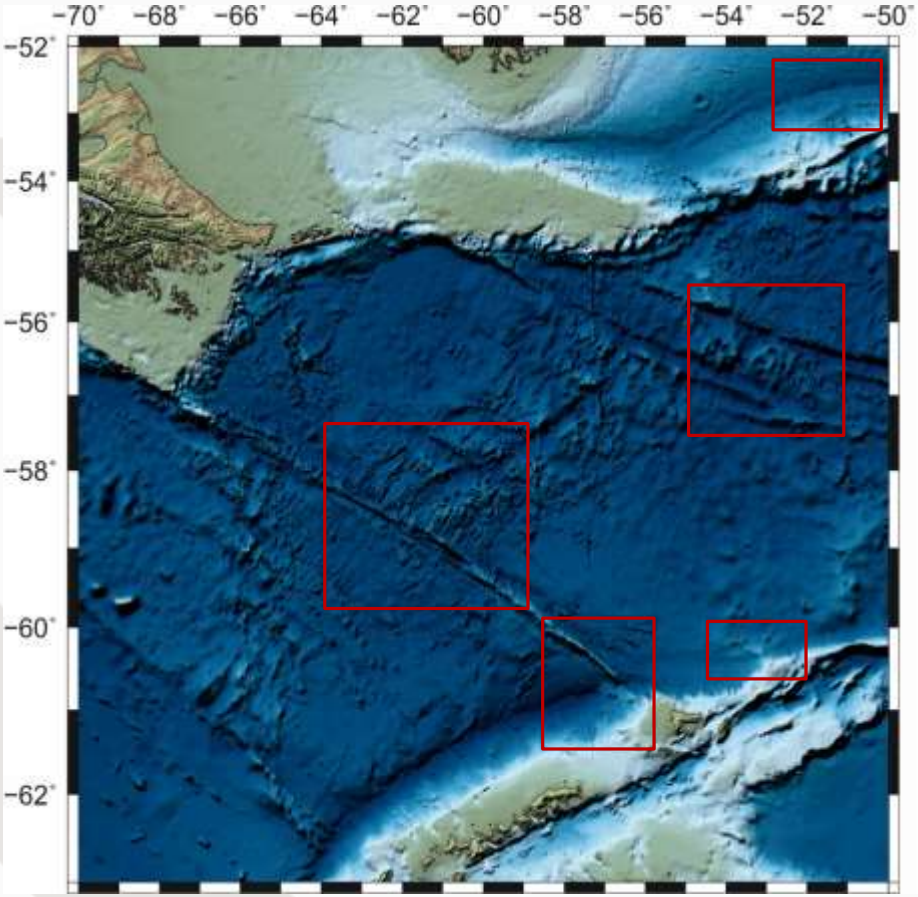
Total data compilation coverage for version BATDRAKE 1.0 - 2014

DATA SOURCES

- BATDRAKE*
- GEBCO
- IBCSO

*BAS+IGME+KOPRI+USA

GEBCO

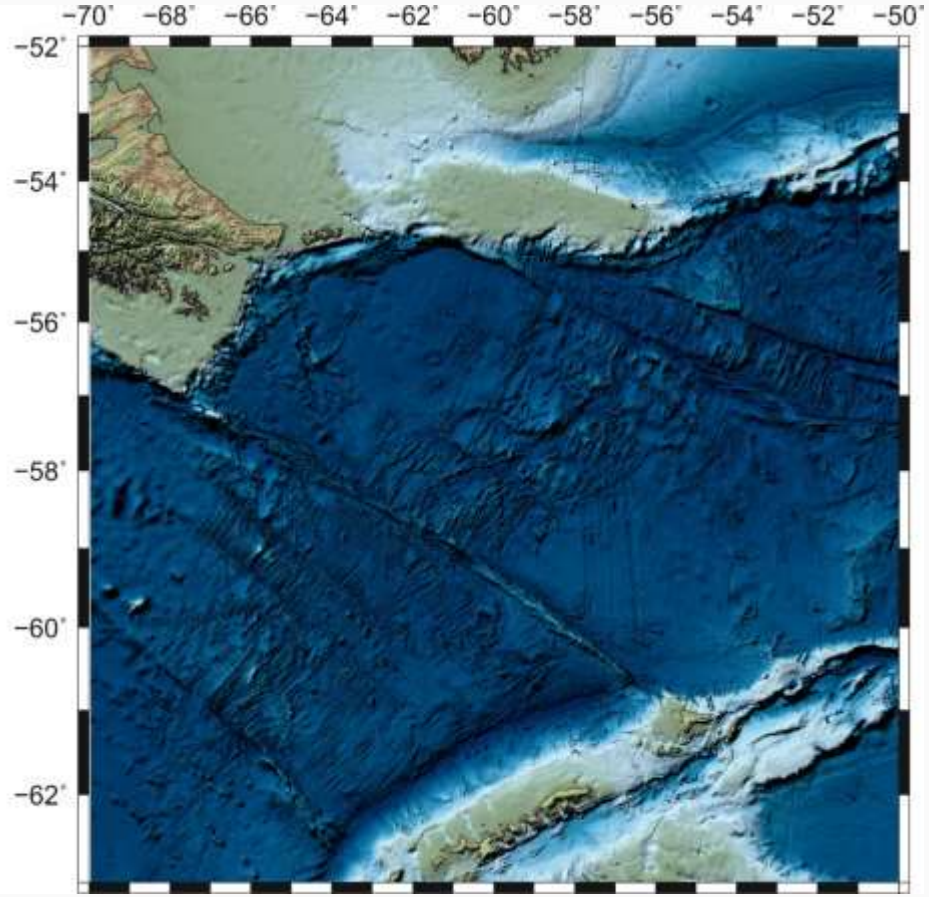


Global Bathymetry (GEBCO)

Low resolution

Wide coverage

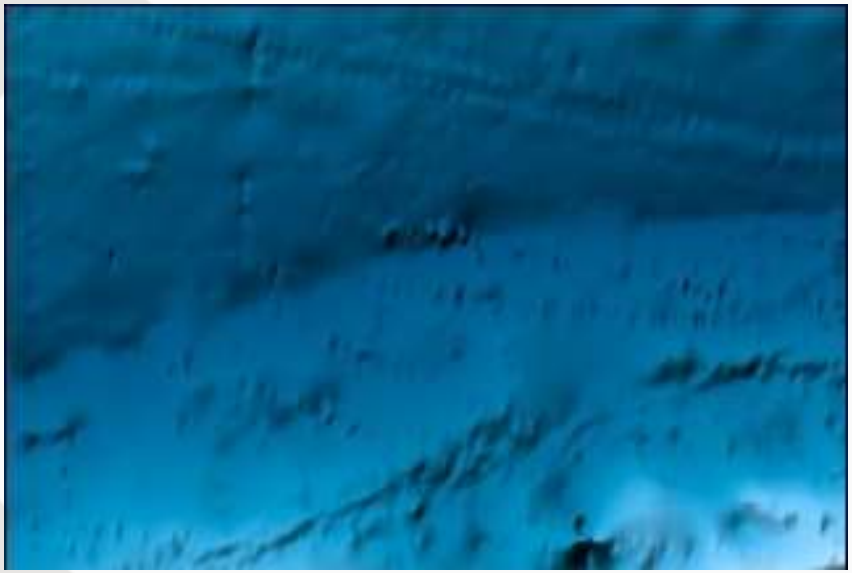
BATDRAKE

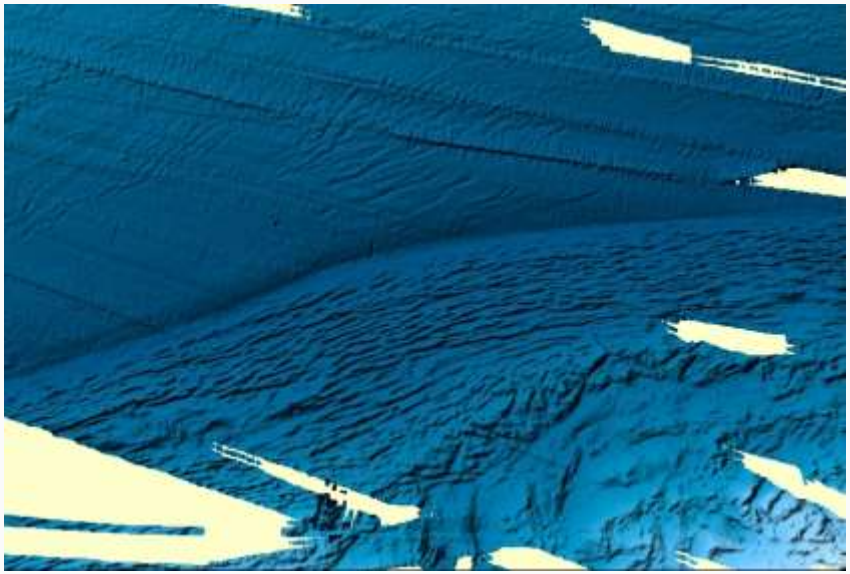


Multibeam Bathymetry

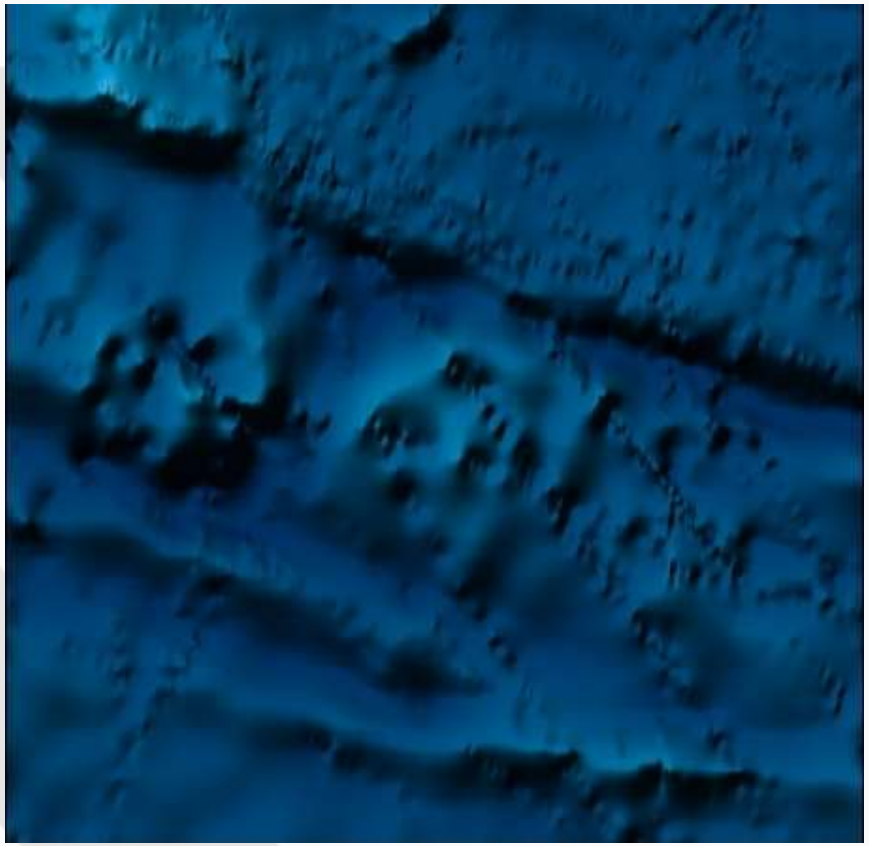
High resolution

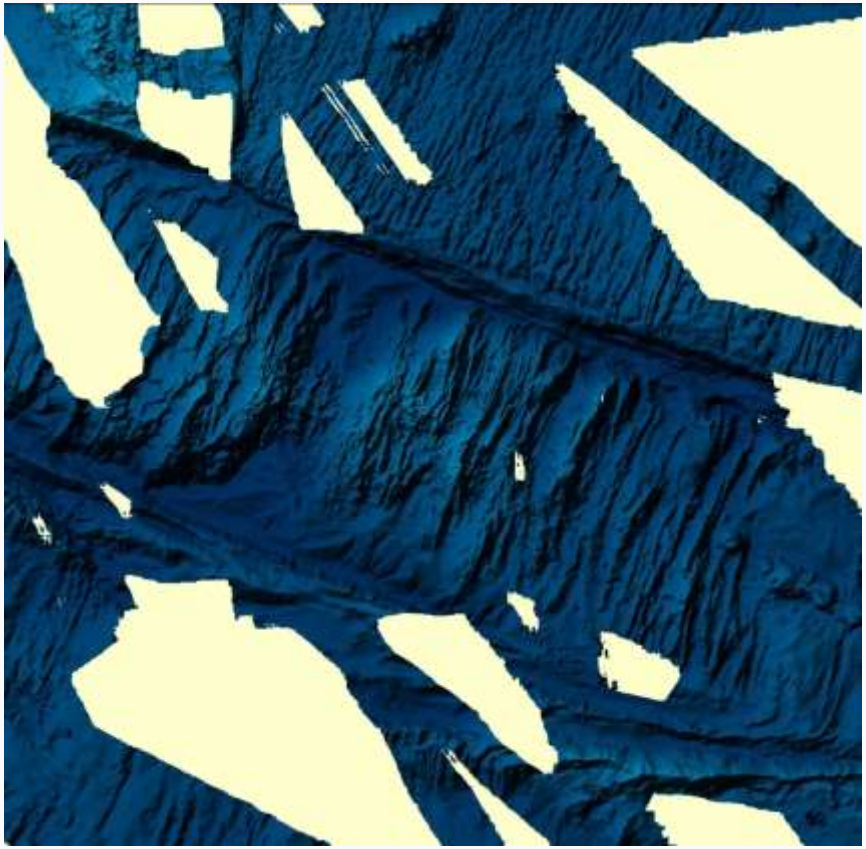
Sparse coverage



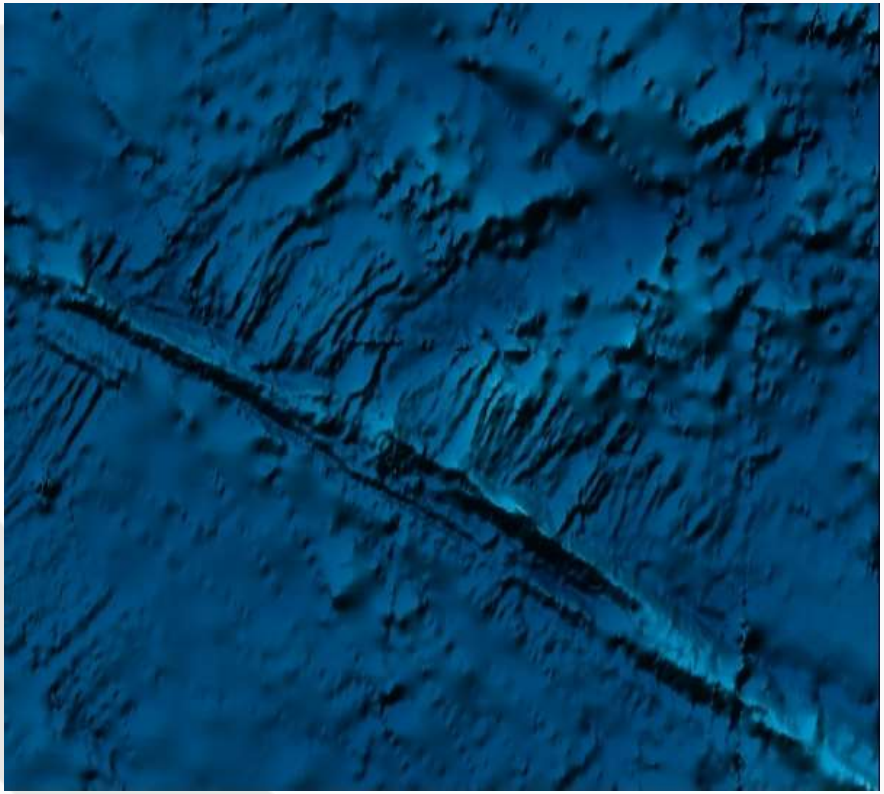


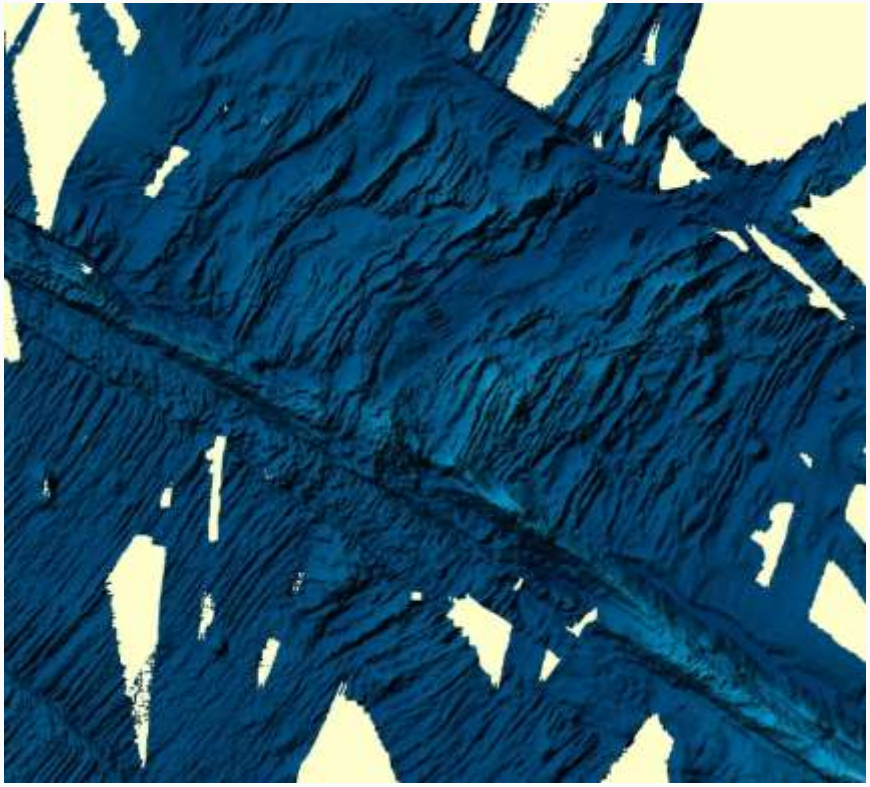
NORTH SCOTIA RIDGE



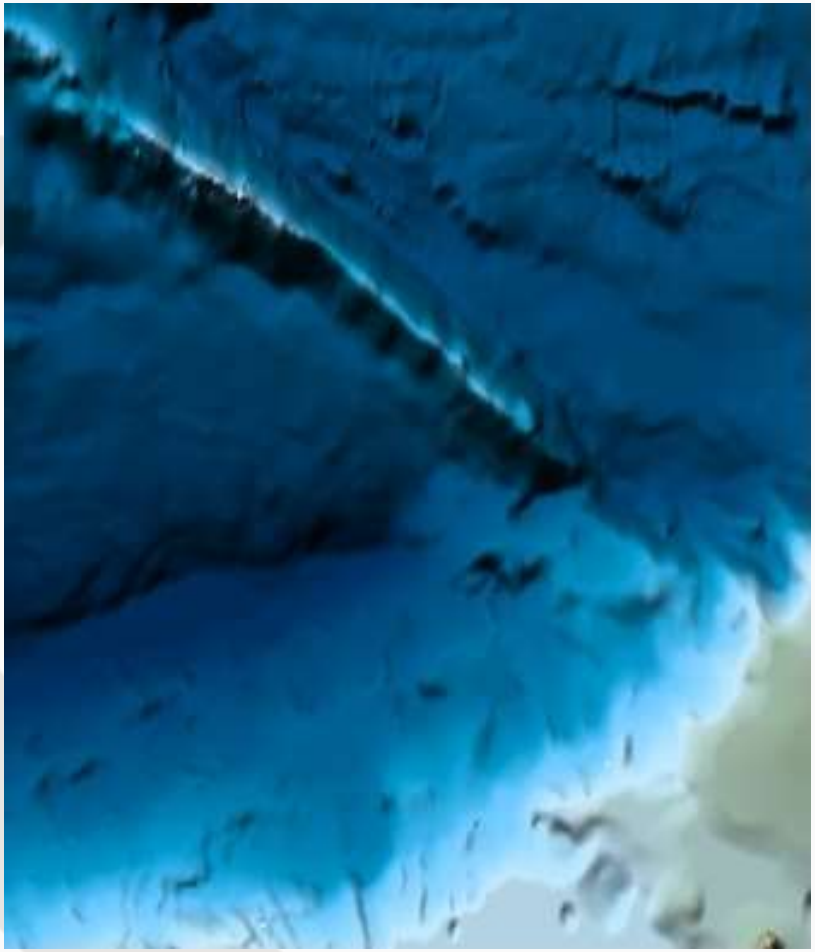


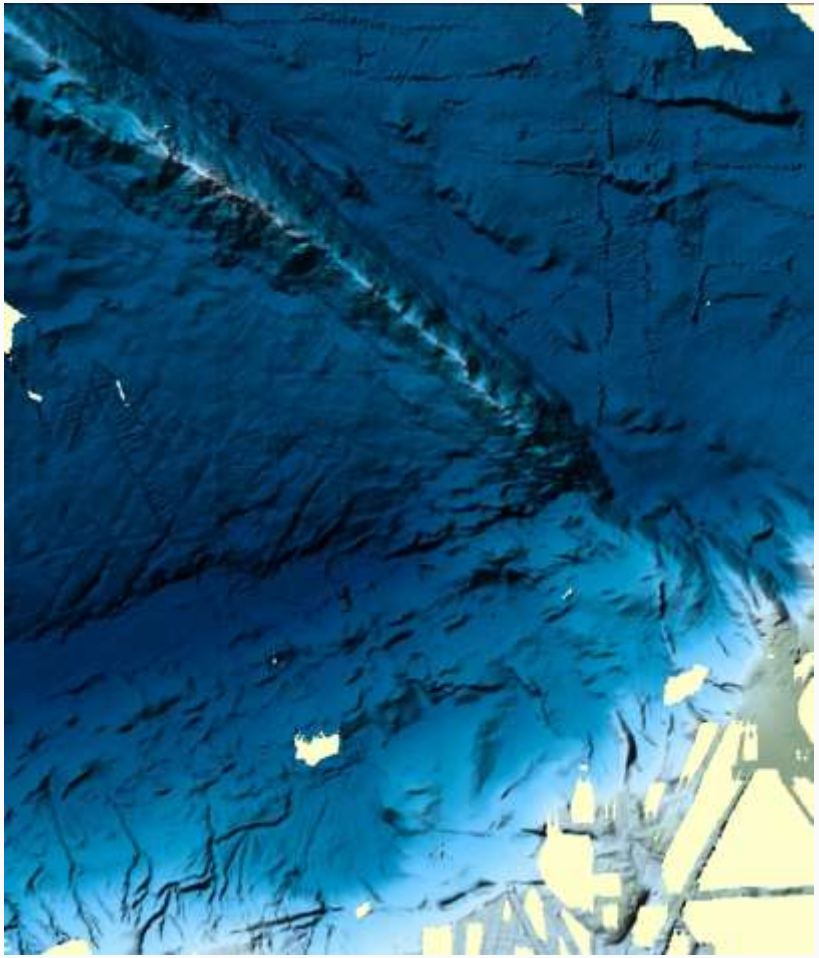
WEST SCOTIA RIDGE



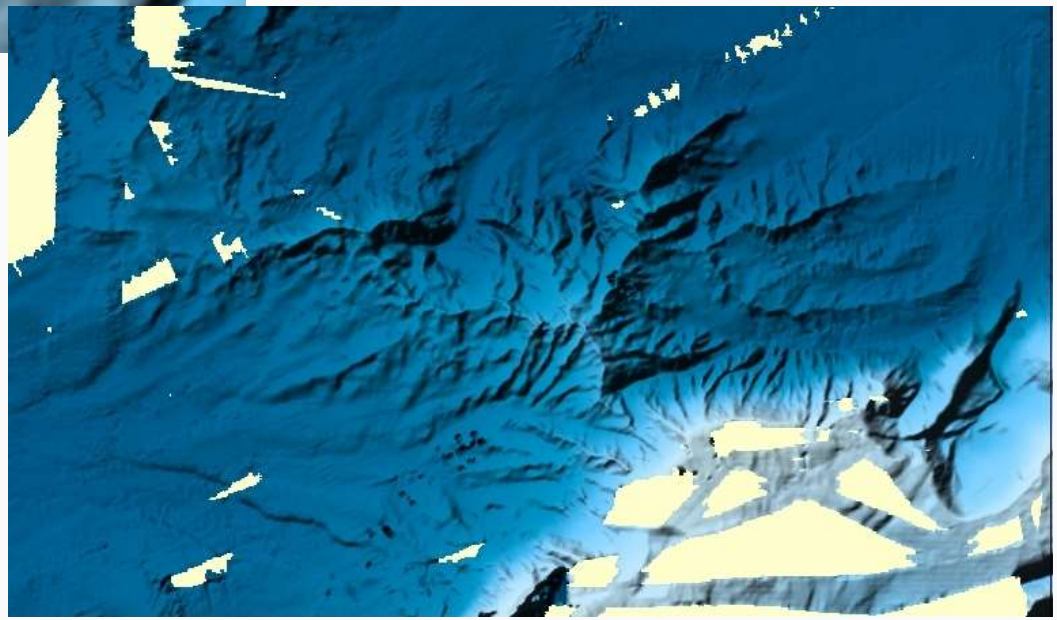


SHACKLETON FRACTURE ZONE

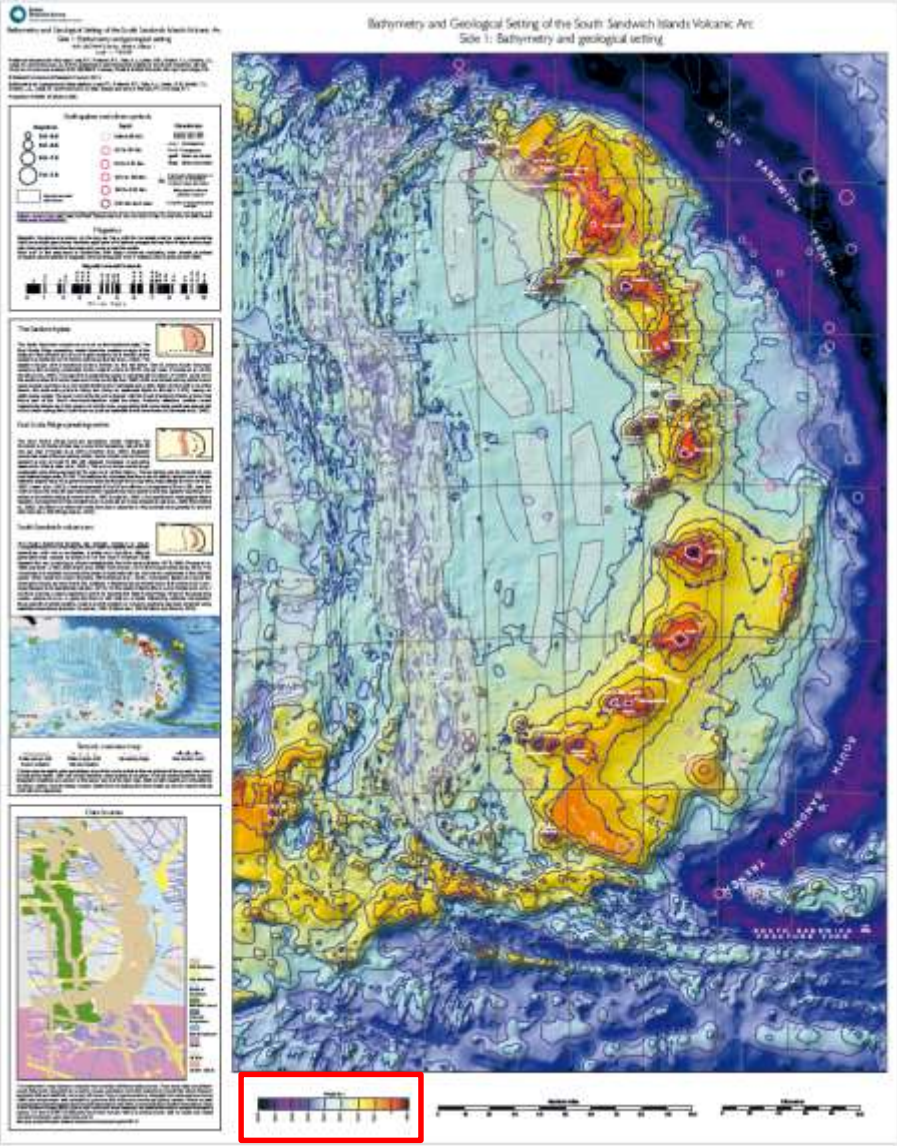


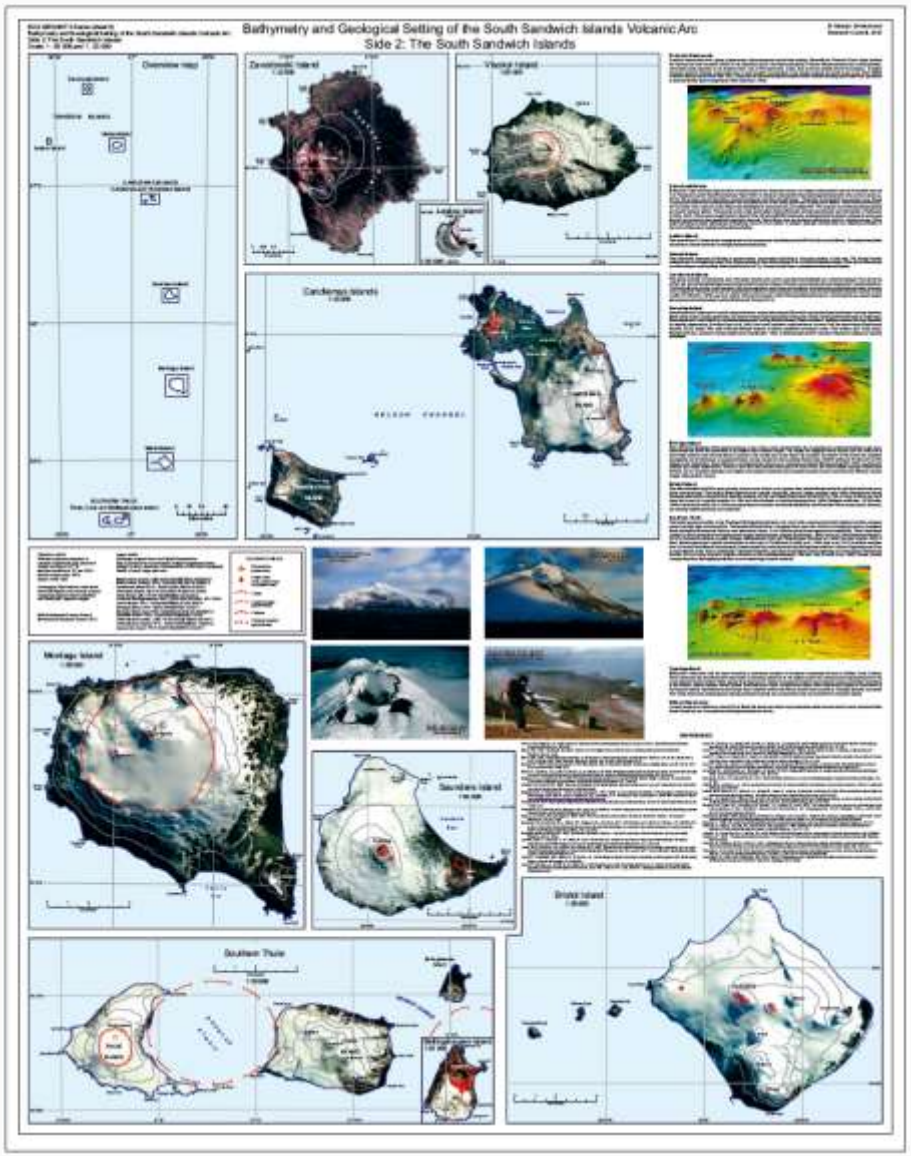


SFZ and NE SOUTH SHETLAND TRENCH



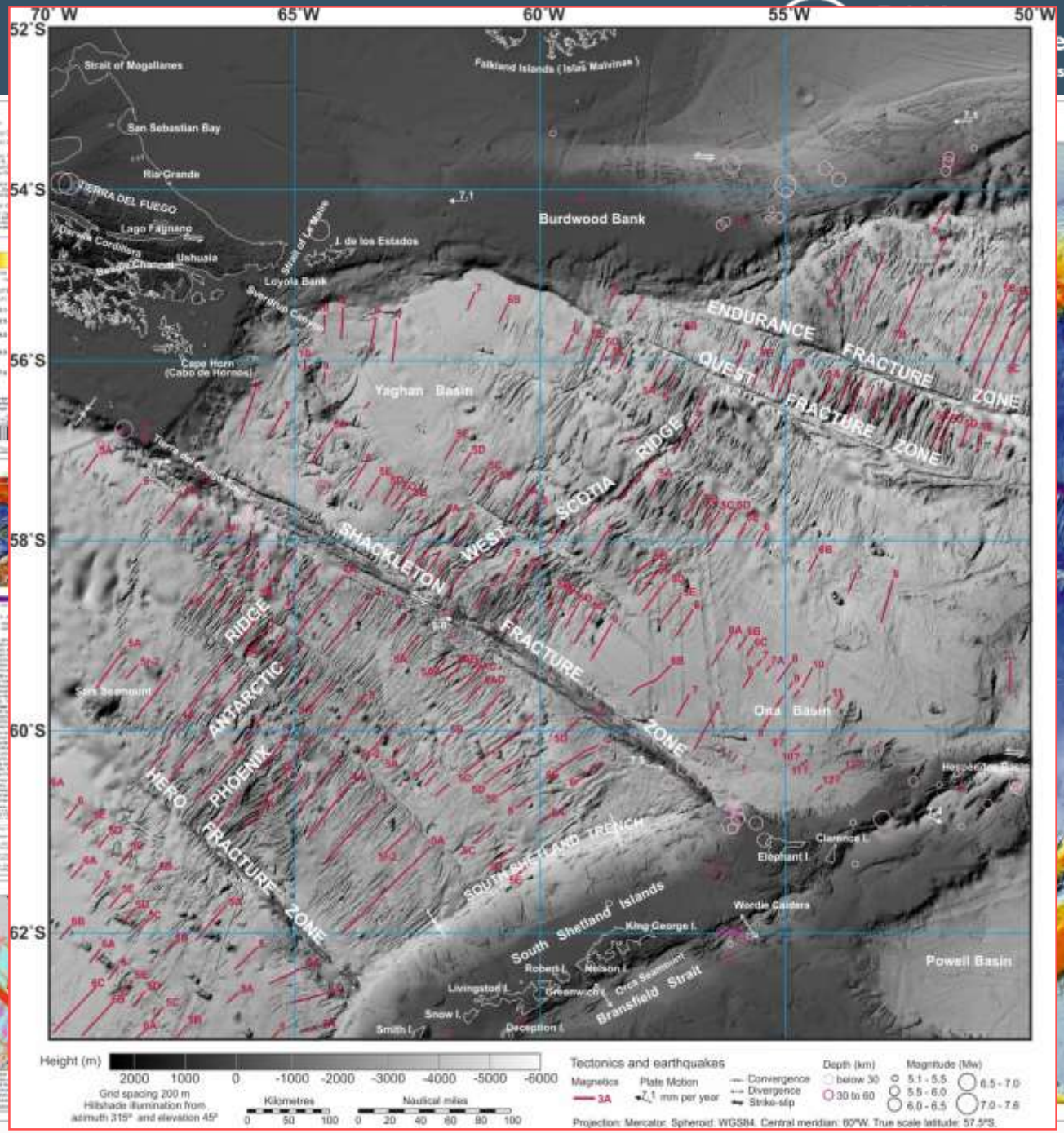
ONA HIGH

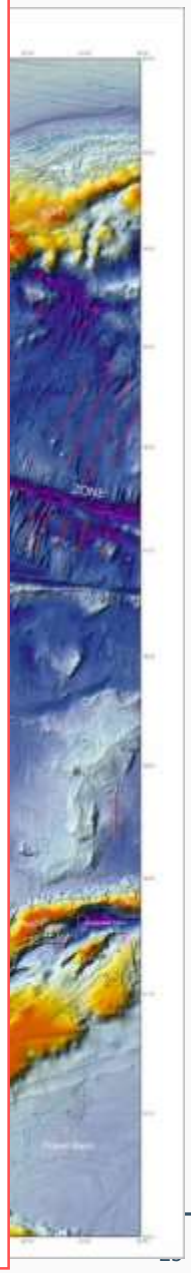

Bathymetry and Geological Setting of the South Sandwich Islands Volcanic Arc
Side 1: Bathymetry and geological setting

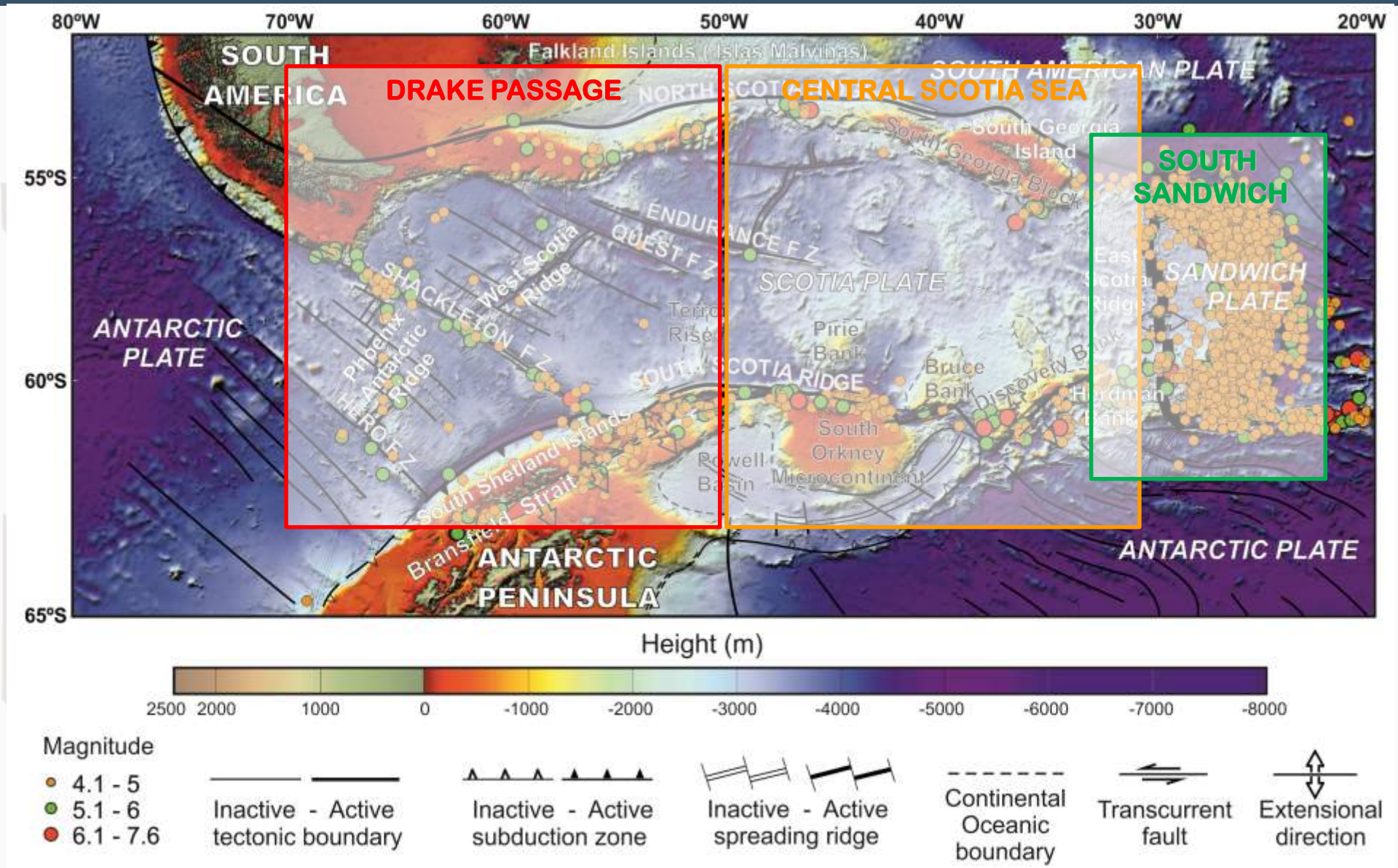

Bathymetry and Geological Setting of the South Sandwich Islands Volcanic Arc
Side 2: The South Sandwich Islands

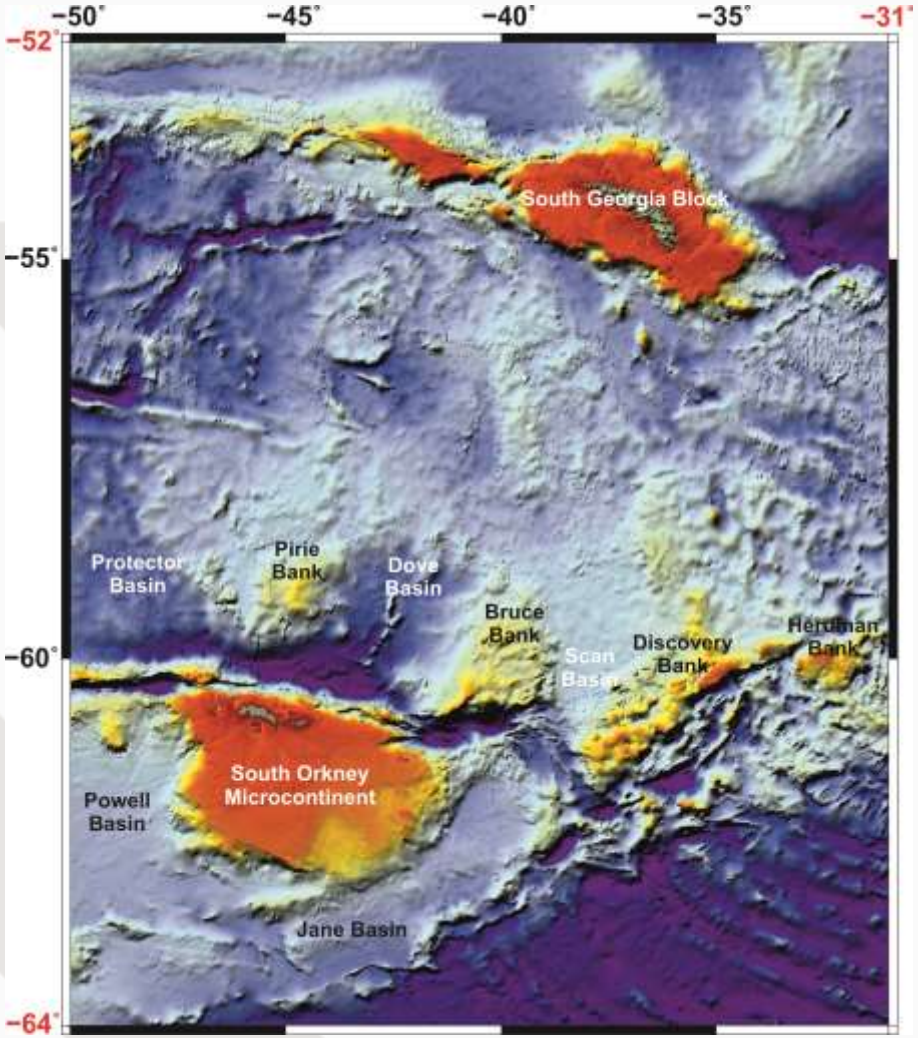

Bathymetry and Geological
Setting of the Drake Passage

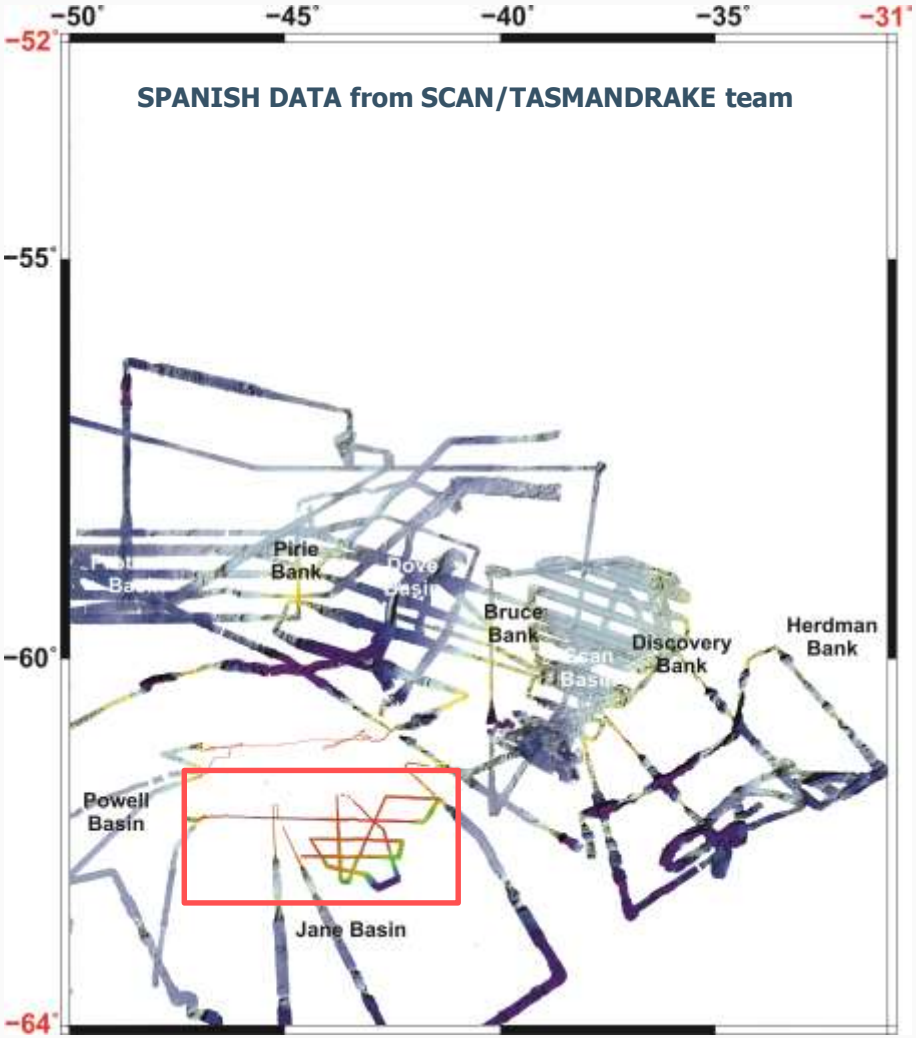

Antarctic Peninsula and Scotia Sea Region


70°W
65°W
60°W
55°W
50°W
52°S
54°S
56°S
58°S
60°S
62°S
Strait of Magallanes
Falkland Islands (Islas Malvinas)
San Sebastian Bay
Rio Grande
TIERRA DEL FUEGO
Lago Fagnano
Darwin Cordillera
Beagle Channel
Ushuaia
Strait of Le Maire
J. de los Estados
Loyola Bank
Burdwood Bank
Cape Horn
(Cabo de Hornos)
Yaghan Basin
ENDURANCE FRACTURE ZONE
QUEST FRACTURE ZONE
SCOTIA RIDGE
WEST SCOTIA RIDGE
SHACKLETON FRACTURE ZONE
ANTARCTIC PHOENIX RIDGE
HERO FRACTURE ZONE
Sars Seamount
Orca Basin
Hesperides Bank
SOUTH SHETLAND TRENCH
Clarence I.
Elephant I.
Wordie Caldera
King George I.
South Shetland Islands
Robert I.
Nelson I.
Livingston I.
Greenwich I.
Orca Seamount
Bransfield Strait
Snow I.
Smith I.
Deception I.
Powell Basin
Height (m)
2000 1000 0 -1000 -2000 -3000 -4000 -5000 -6000
Grid spacing 200 m
Hillshade illumination from
azimuth 315° and elevation 45°
Kilometres
0 50 100
Nautical miles
0 20 40 60 80 100
Tectonics and earthquakes
Magnetics
3A
Plate Motion
mm per year
Convergence
Divergence
Strike-slip
Depth (km)
below 30
30 to 60
Magnitude (Mw)
5.1 - 5.5
5.5 - 6.0
6.0 - 6.5
6.5 - 7.0
7.0 - 7.9
Projection: Mercator. Spheroid: WGS84. Central meridian: 60°W. True scale latitude: 57.5°S.




80ºW
70ºW
60ºW
50ºW
40ºW
30ºW
20ºW
55ºS
60ºS
65ºS
SOUTH AMERICA
Falkland Islands (Islas Malvinas)
DRAKE PASSAGE
CENTRAL SCOTIA SEA
SOUTH SANDWICH
SOUTH AMERICAN PLATE
South Georgia Island
South Georgia Block
ENDURANCE F Z
QUEST F Z
SCOTIA PLATE
SANDWICH PLATE
West Scotia Ridge
SHACKLETON F Z
Phoenix Antarctic Ridge
Terra Rise
Pirie Bank
Bruce Bank
Discovery Bank
Hardman Bank
SOUTH SCOTIA RIDGE
South Orkney Microcontinent
Powell Basin
South Shetland Islands
Bransfield Strait
ANTARCTIC PLATE
ANTARCTIC PENINSULA
ANTARCTIC PLATE
Height (m)
2500 2000 1000 0 -1000 -2000 -3000 -4000 -5000 -6000 -7000 -8000
Magnitude
4.1 - 5
5.1 - 6
6.1 - 7.6
Inactive - Active tectonic boundary
Inactive - Active subduction zone
Inactive - Active spreading ridge
Continental Oceanic boundary
Transcurrent fault
Extensional direction


-50°
-45°
-40°
-35°
-31°
-52°
-55°
-60°
-64°
South Georgia Block
Protector Basin
Pirie Bank
Dove Basin
Bruce Bank
Scan Basin
Discovery Bank
Herdman Bank
South Orkney Microcontinent
Powell Basin
Jane Basin


SPANISH DATA from SCAN/TASMANDRAKE team
-50°
-45°
-40°
-35°
-31°
-52°
-55°
-60°
-64°
Pirie Bank
Bruce Bank
Discovery Bank
Herdman Bank
Powell Basin
Jane Basin

Bohoyo, F., Larter, R.D., Galindo-Zaldívar, J., Leat, P.T., Maldonado, A., Tate, A.J., Gowland, E.J.M., Arndt, J.E., Dorschel, B., Kim, Y.D., Hong, J.K., Flexas, M., López-Martínez, J., Maestro, A., Bermudez, O., Nitsche, F.O., Livermore, R.A., Riley, T.R. **2016**. Bathymetry and Geological Setting of the Drake Passage (1:1 500 000). BAS GEOMAP 2 Series, Sheet 7, British Antarctic Survey, Cambridge,

Morphological and geological features of Drake Passage, Antarctica, from a new digital bathymetric model. 2018. Bohoyo, F.; Larter, R.D.; Galindo-Zaldívar, J.; Leat, P.T.; Maldonado, A.; Tate, A.J.; Gowland, E.J.M.; Arndt, J.E.; Dorschel, B.; Kim, Y.D.; Hong, J.K.; Flexas, M.M.; Lopez-Martinez, J.; Maestro, A.; Bermudez, O.; Nitsche, F.O.; Livermore, R.A.; Riley, T.R. *Accepted in Journal of Maps*

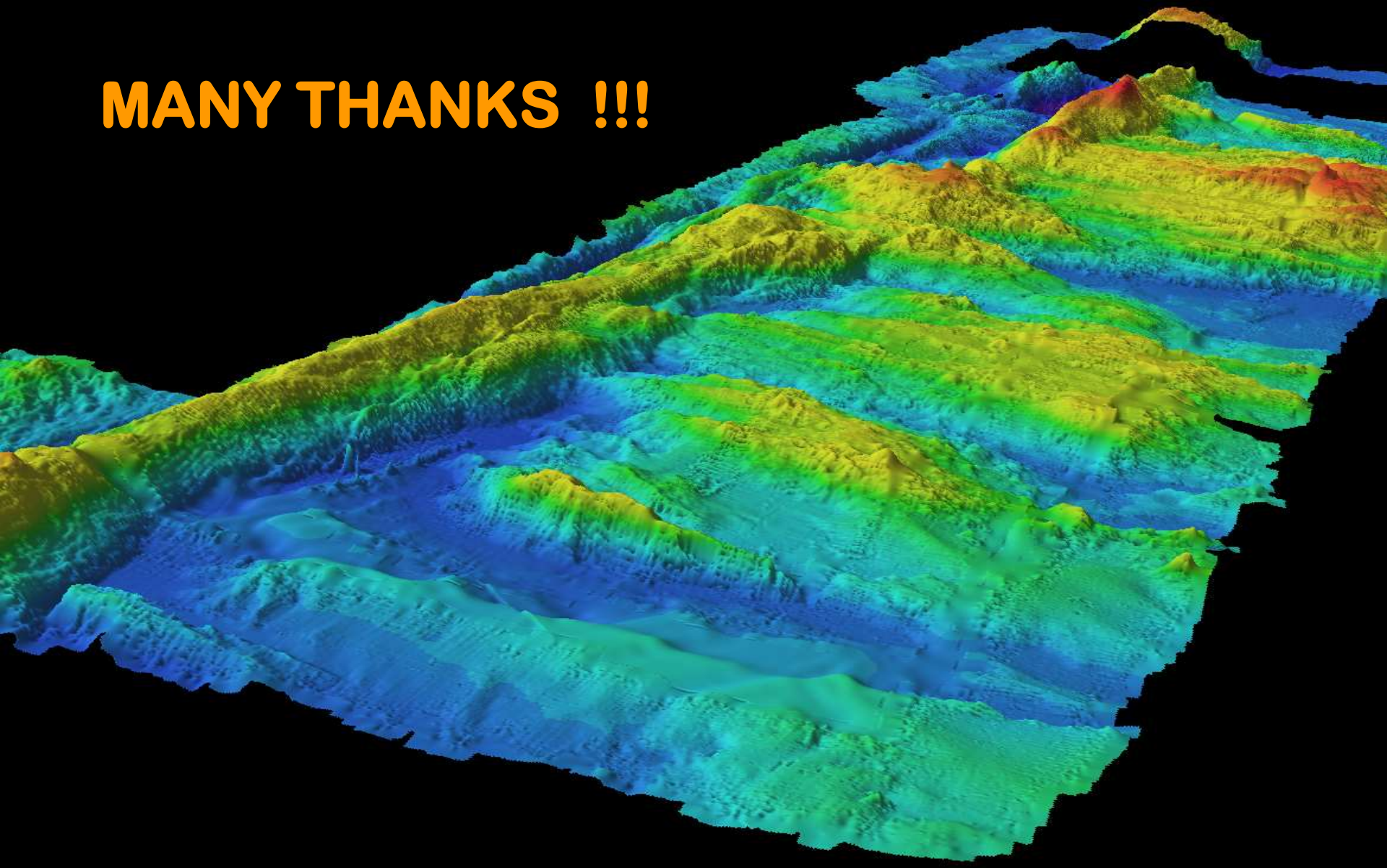
GRID after publication in JoM will be hosted at the **BAS** and **IGME** webservers www.igme.es and www.bas.ac.uk . END of 2018

Bathymetry and Geological Setting of the Central Scotia Sea (1:1 500 000). BAS GEOMAP 2 Series, Sheet 8, British Antarctic Survey, Cambridge. IGME, BAS and AWI . 2019

Tectonic Map of the Scotia Arc (1:3 000 000). BAS GEOMAP 2 Series, Sheet 9, British Antarctic Survey, Cambridge. IGME, BAS and AWI . 2020 – 35 years later !!!

Instituto Geológico
y Minero de España

MANY THANKS !!!



Shackleton Fracture Zone (ANTPAC 97/98 cruise)