D1428

GEOMAR Helmholtz Centre for Ocean Research Kiel

Geological mapping in the offshore domain: unravelling the tectonic history of the Scotia Sea

vrije Universiteit amsterdam

The End

Or here!

Anouk Beniest and Wouter Schellart

Why are offshore geological maps useful?

1. Less-time consuming, economically advantageous method for mapping offshore domains
2. Help us understand tectonically complex and inaccessible (submerged) areas
3. Serve as guidelines for future expeditions in remote areas

Click here!

START

#shareEGU20
EGU General Assembly 2020
TS 14.1 Celebrating the 100th birth anniversary of Marie Tharp

Contact: abeniest@geomar.de

START: How to make an offshore geological map?

The End

HOW?

STEP 1: DATA

STEP 2: MAP

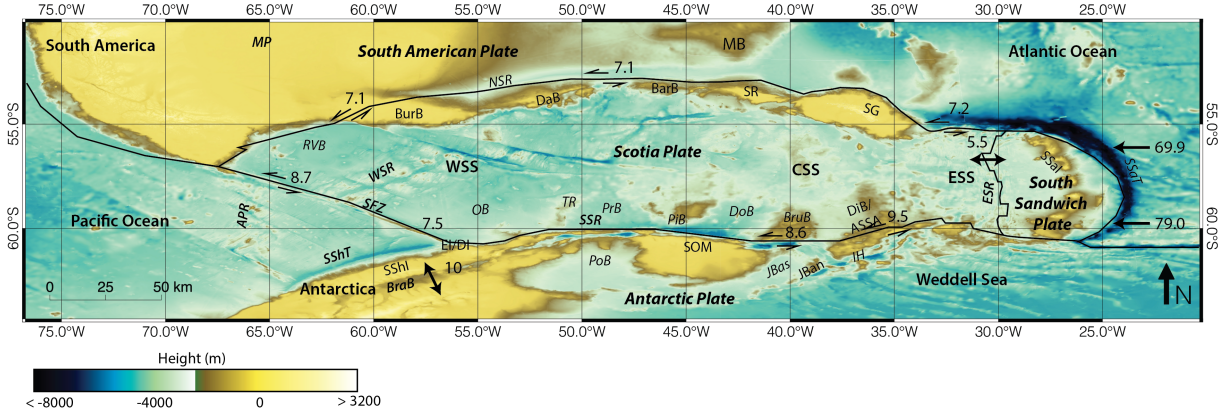
STEP 3: INTERPRETATION

STEP 4: TECTONIC HISTORY

WHY?

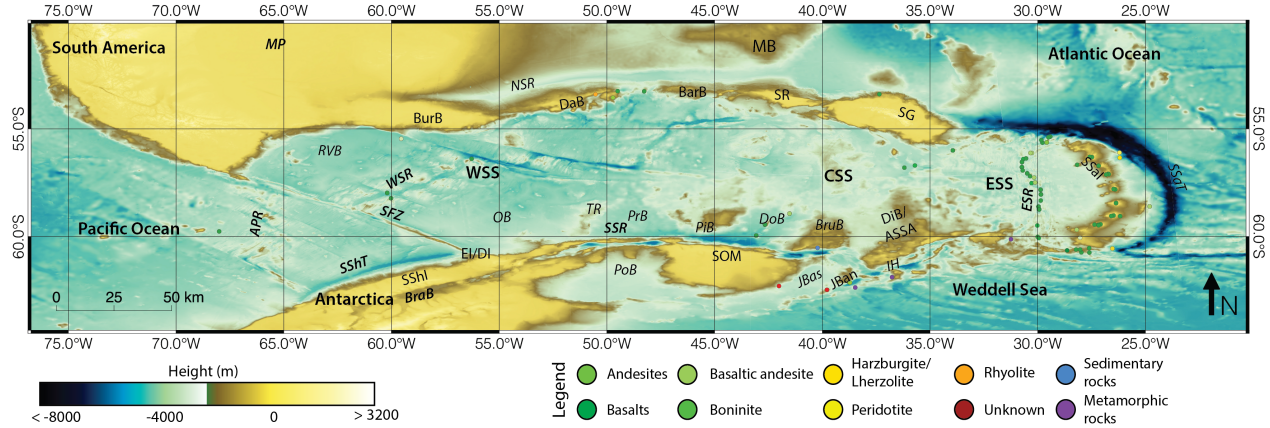
STEP 1: Harvesting of publicly available geological and geophysical data

Bathymetric Map Scotia Sea



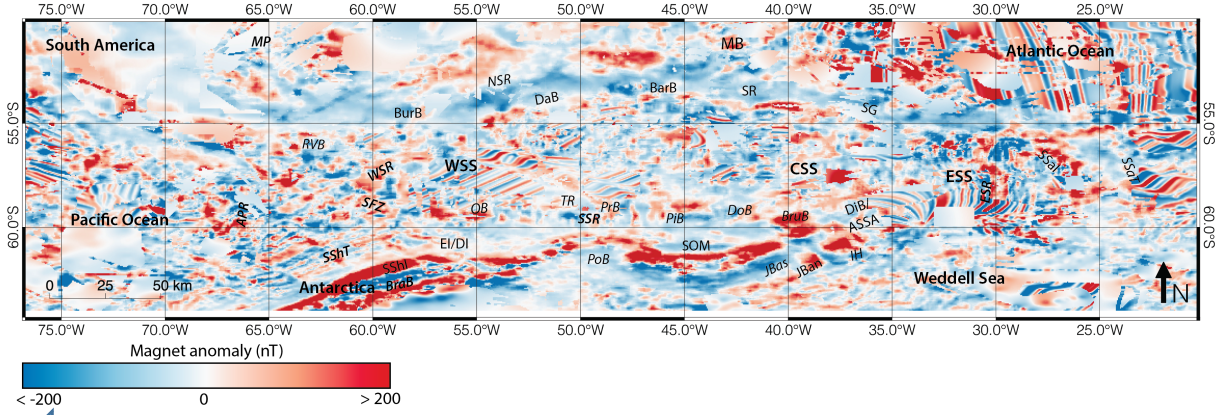
[GEBCO30](), Wheaterall et al., 2015

Dredge Locations Scotia Sea



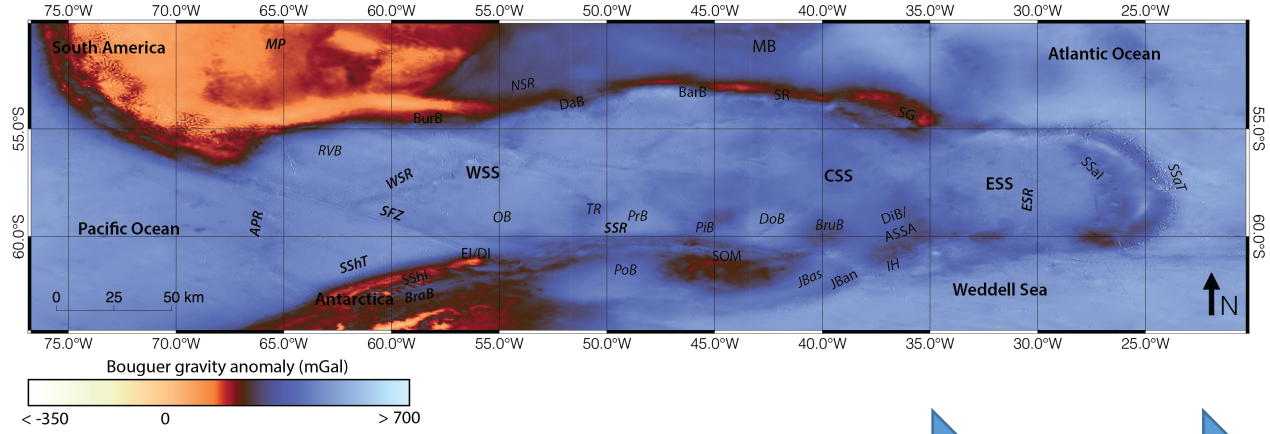
[EarthChem Portal](), PetDB, Lehnert et al., 2000

Magnetic Anomaly Map Scotia Sea



[World Magnetic Anomaly Map](), Dyment et al., 2015

Bouguer Gravity Anomaly Map Scotia Sea



World Gravity Anomaly Map ([WGM2012]()), Balmino et al., 2011

START

HOW?

STEP 2

How: Characterize rock-types

Lithology	Colour	Gravity signal	Magnetic pattern	Bathymetric features
Basalt		450-500	Clear striped pattern	Regular relief visible with parallel running features
Basaltic-andesite		500-550	Unclear striped pattern	Elevated plateaus
Dacite		300	No pattern	Not observed on bathymetry
Volcanic island (basalts)		400-500	No pattern	Circular, cone-shaped features, with or without crater
Alkali basalt		100-200	No pattern	Not observed on bathymetry
Mantle material		500	No pattern	Not observed on bathymetry
Intrusive material		-200	No pattern	Not observed on bathymetry
Metamorphic and/or sedimentary rock		250-350	Uniform anomaly	Elevated features, chaotic surface pattern
Volcanoclastic		400-450	No pattern	Smooth, more elevated surface around circular features. Sometimes with fan-like structure
Oceanic sediments		400-450	Striped pattern	Smooth surface, predominantly in lower areas

Every rock-type has a unique geophysical signature.

This signature is a combination of

- The gravity anomaly signal
  (e.g. higher, positive anomaly is denser material)
- The magnetic pattern
  (e.g. striped pattern is typical for mafic material)
- Bathymetric expression
  (e.g. rough surface, smooth surface, (a)symmetric appearance…)

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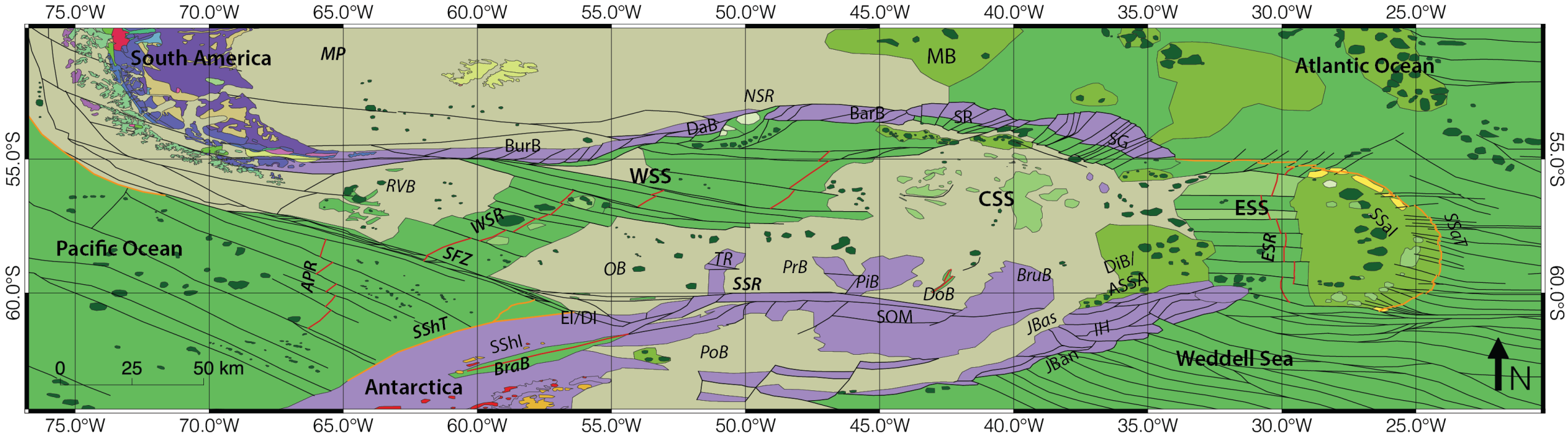
STEP 2

STEP 2: Draw structural and lithological map



Legend

- Basalt
- Basaltic-andesite
- Dacite
- Volcanic island (basalts)
- Alkali basalt
- Mantle material
- Intrusive material
- Metamorphic and/or sedimentary rock
- Volcanoclastic
- Oceanic sediment
- Faults
- Subduction zone
- Spreading center

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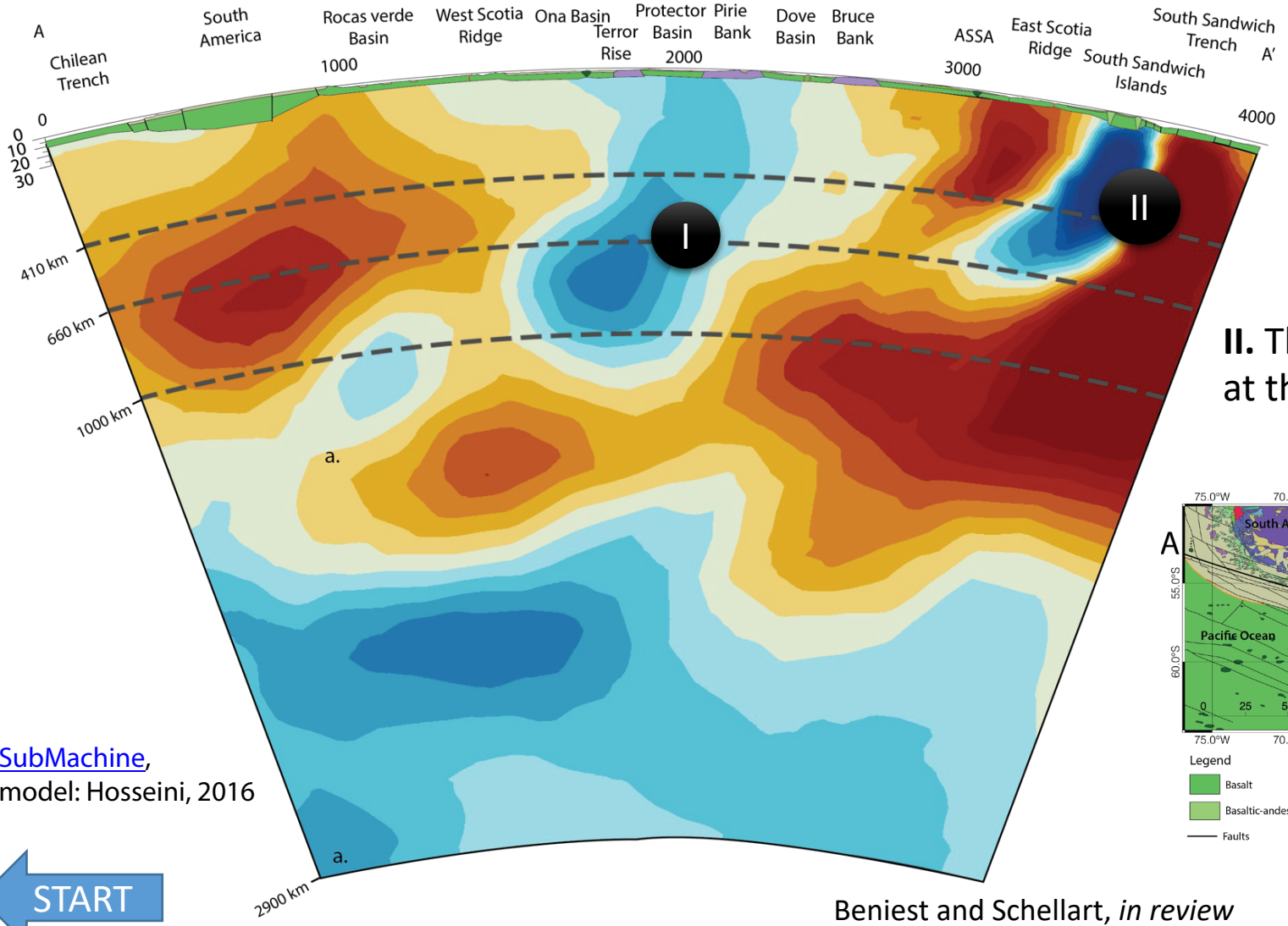
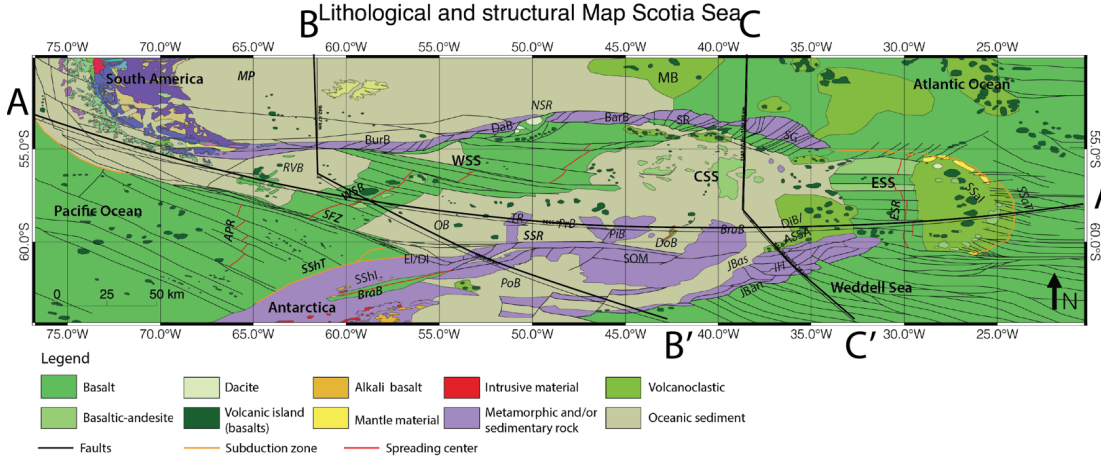
STEP 3a | STEP 3b | STEP 3c | STEP 4

STEP 3a: Interpret crustal cross-sections combined with mantle tomography



I. Remnant slab material of the Ancestral South Sandwich Arc (ASSA) below and south of the South Scotia Ridge (SSR)

II. The actively subducting slab of oceanic lithosphere at the South Sandwich Trench



SubMachine, model: Hosseini, 2016

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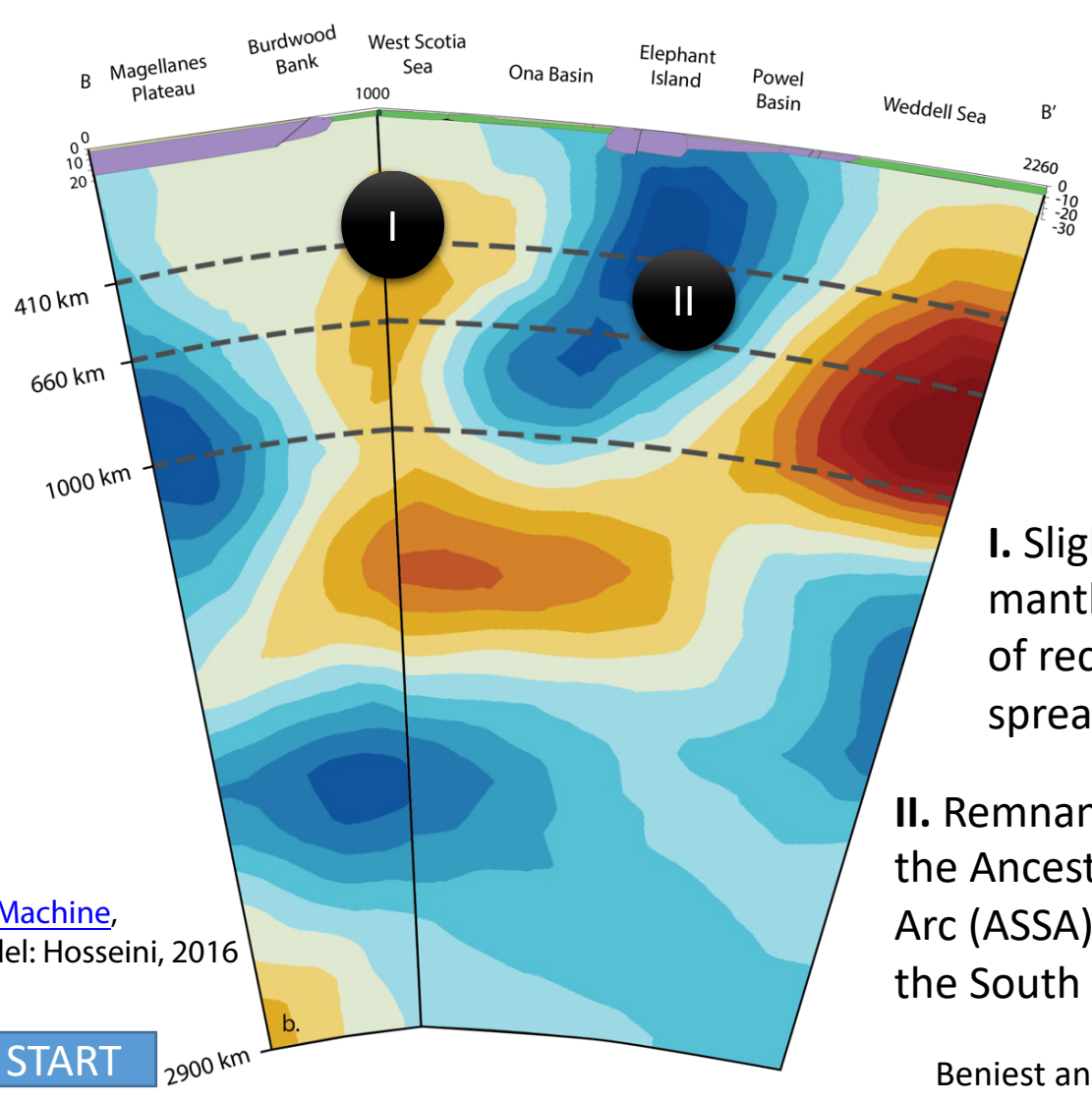
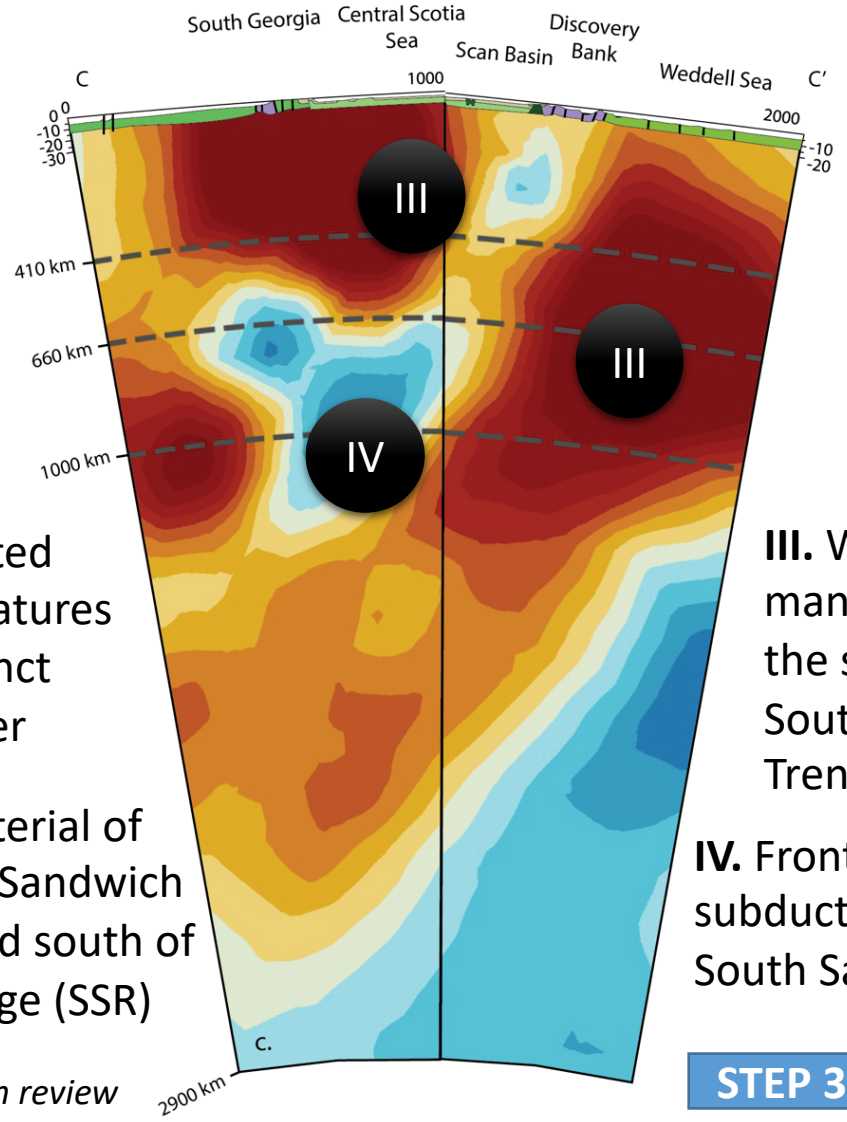
START
STEP 3b
STEP 3c
STEP 4

STEP 3b: Interpret crustal cross-sections combined with mantle tomography





I. Slightly elevated mantle temperatures of recently extinct spreading center

II. Remnant slab material of the Ancestral South Sandwich Arc (ASSA) below and south of the South Scotia Ridge (SSR)

III. Warmer toroidal mantle flow around the slab edge at the South Sandwich Trench

IV. Frontal part of the subducting slab at the South Sandwich Trench

SubMachine, model: Hosseini, 2016

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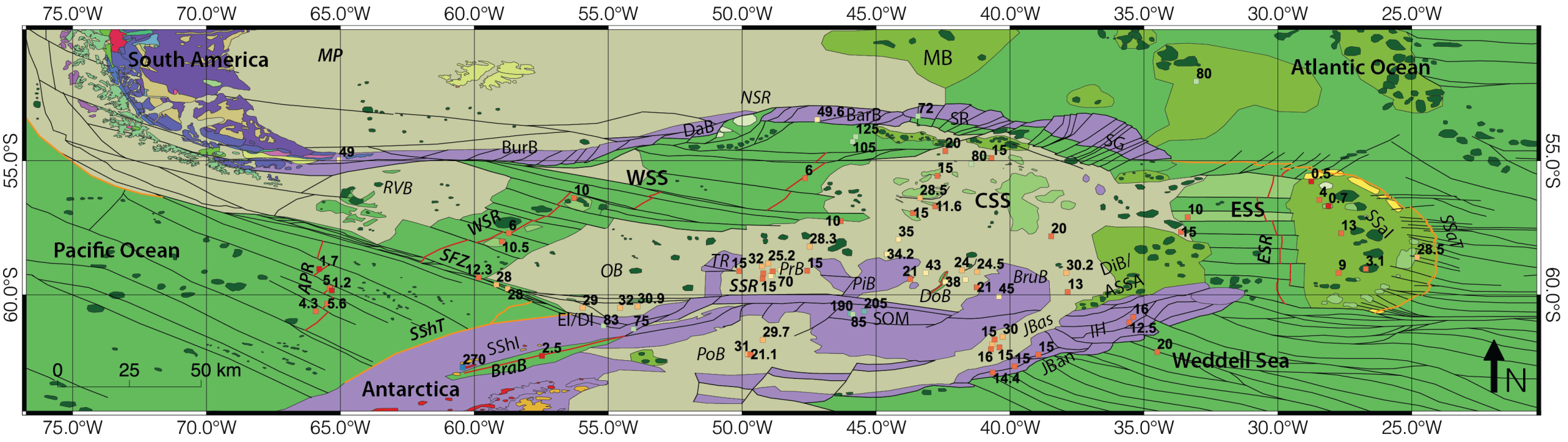
STEP 3c

STEP 4

STEP 3c: Interpret ages of the crustal parts

Crustal Ages Scotia Sea



Age (Ma)

0 2.6 23 34 56 66 145 > 250

Legend

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- Oceanic sediment
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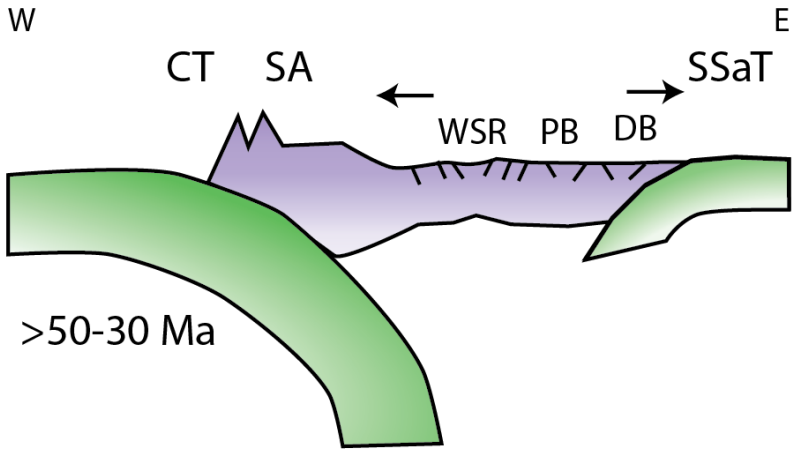
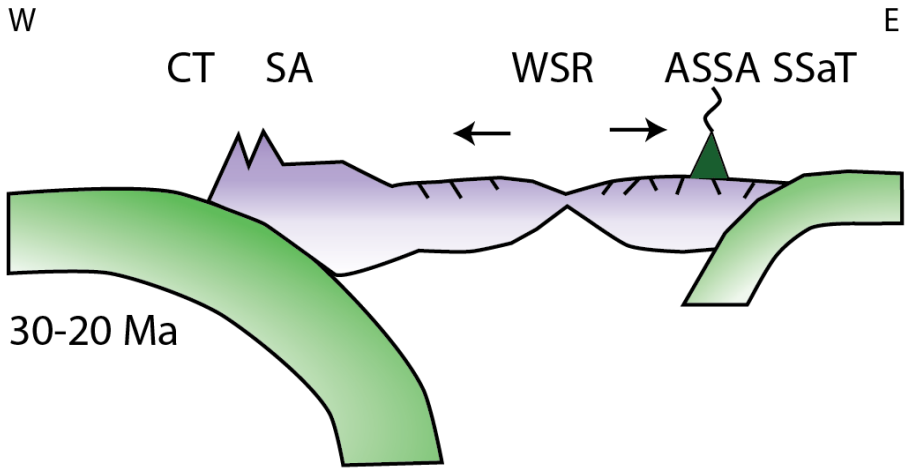
START

STEP 4

STEP 4: Draw tectonic history of the Scotia Sea area



a. 1st rift phase



b. 1st spreading phase

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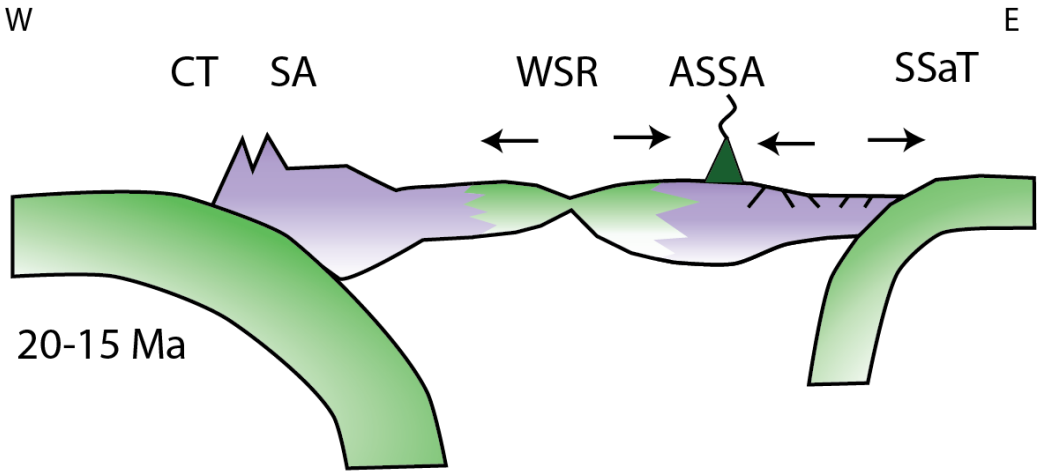
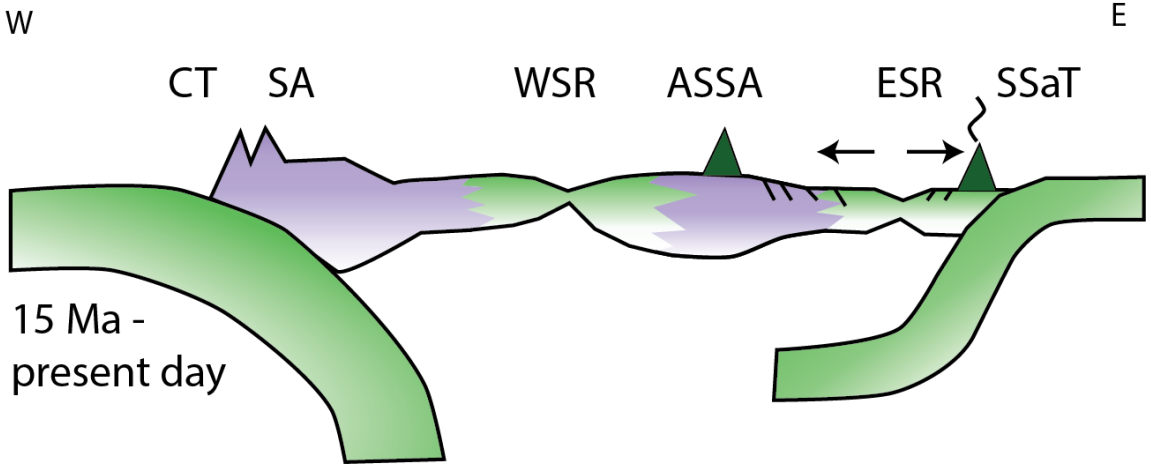


c. 1st spreading & 2nd rift phase



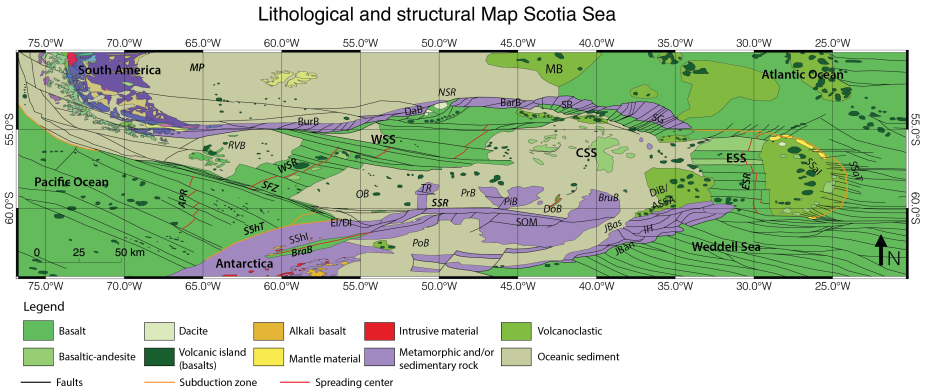
d. 2nd spreading phase

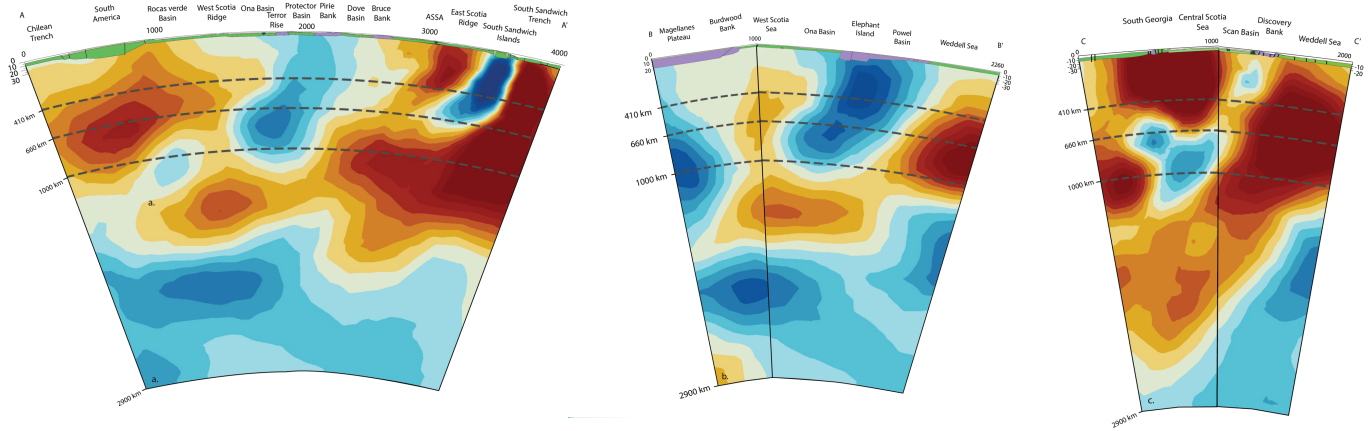
START

THE END

The End: Conclusion

1. It is possible to make a geological map of the publicly available geological and geophysical data





2. Combining crustal cross-sections with mantle tomography is a powerful tool to identify mantle structures

3. The Scotia Sea has a multi-phase rift- and spreading history