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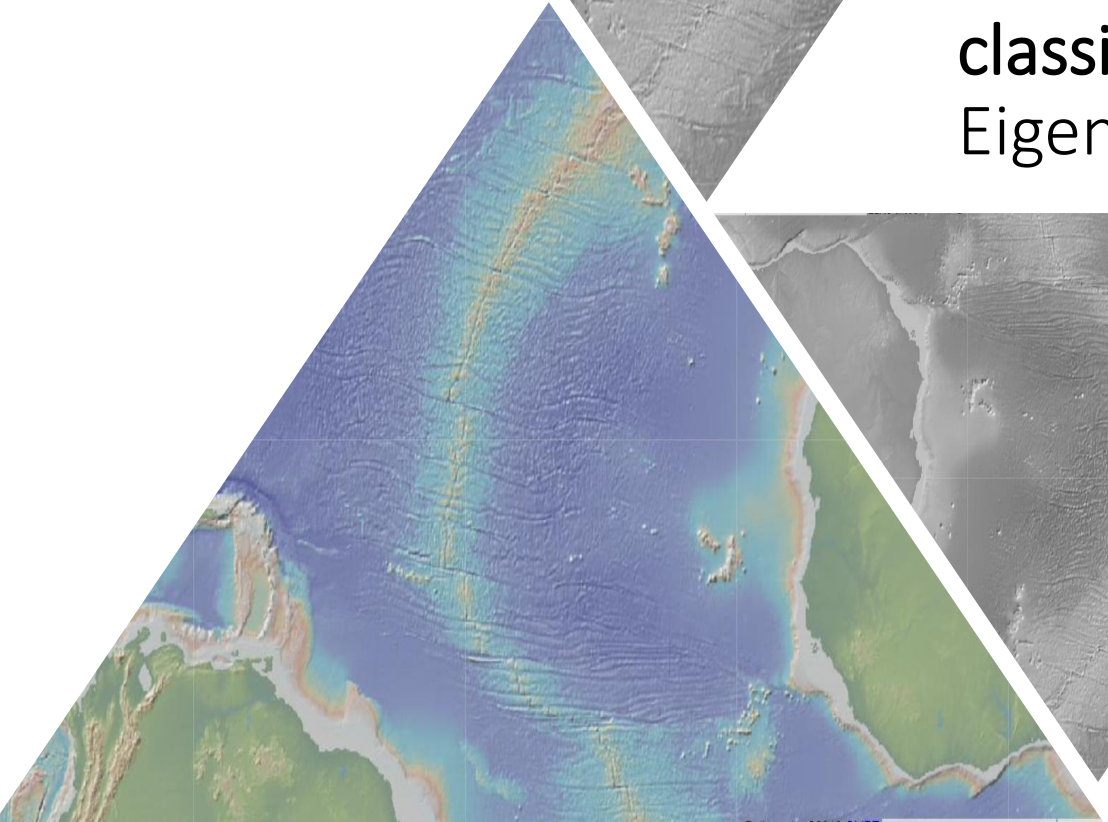

A novel approach for oceanic spreading **terrain classification** at the Mid-Atlantic Ridge using Eigenvalues of **high-resolution bathymetry**

Gabriella Alodia[1], Chris Green[1,2],

Andrew McCaig[1], Douglas Paton[1]

[1]**University of Leeds** × [2]Getech, plc.

Correspondence:
eega@leeds.ac.uk

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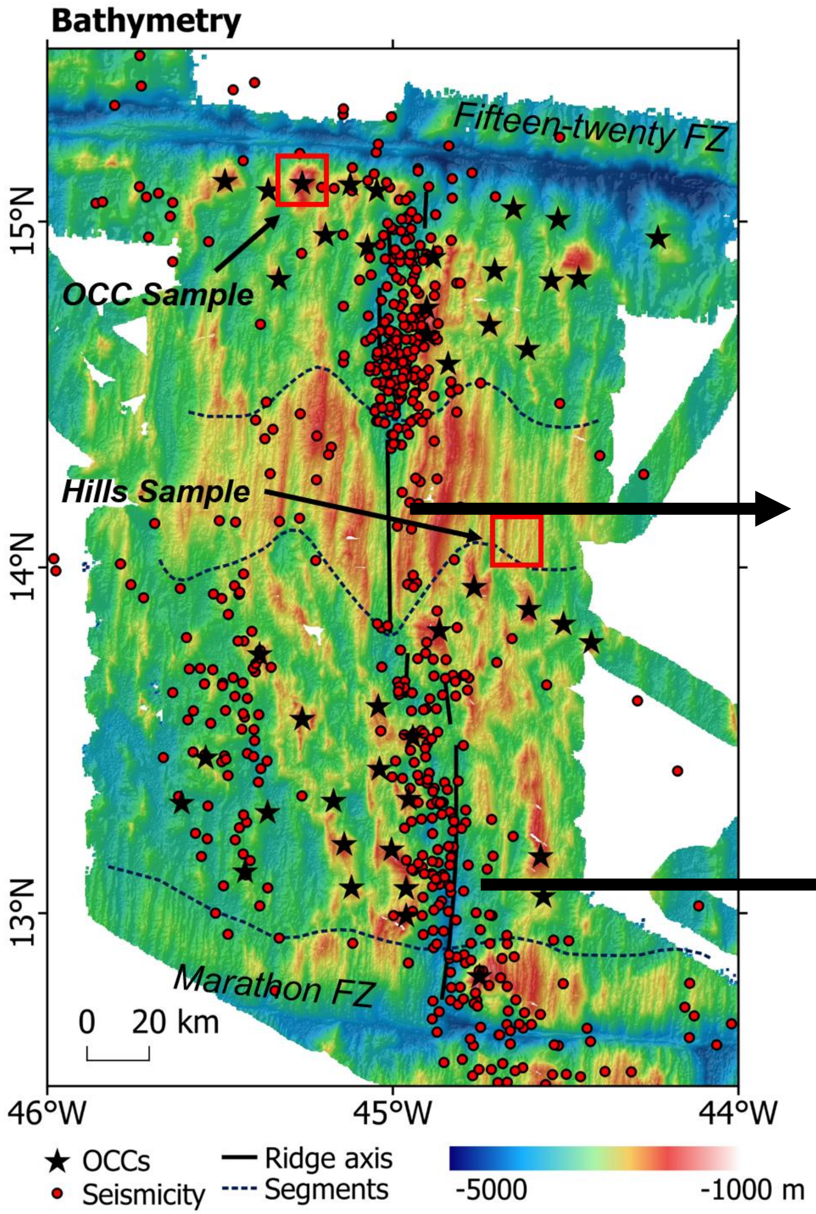
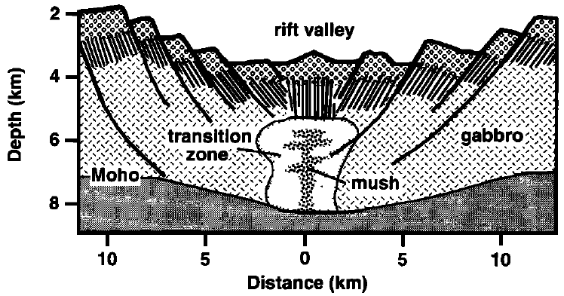


Adapted from Smith et al. (2008)

1. Introduction

Two distinct types of terrain at slow-spreading ridges:

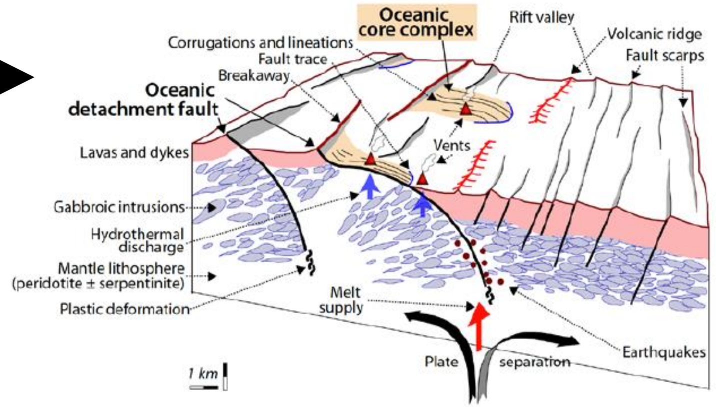
Magmatic hills and Oceanic Core Complex (OCC)



(Sinton & Detrick, 1992)

Magmatic hills characteristics:

- Linear short-lived faults
- Symmetrical on both flanks of axis
- Bi-directional abyssal hills



(Escartín & Canales, 2011)

OCC characteristics:

- Displaced by long-lived detachment fault
- Formed at one flank of the axis
- Omni-directional massifs

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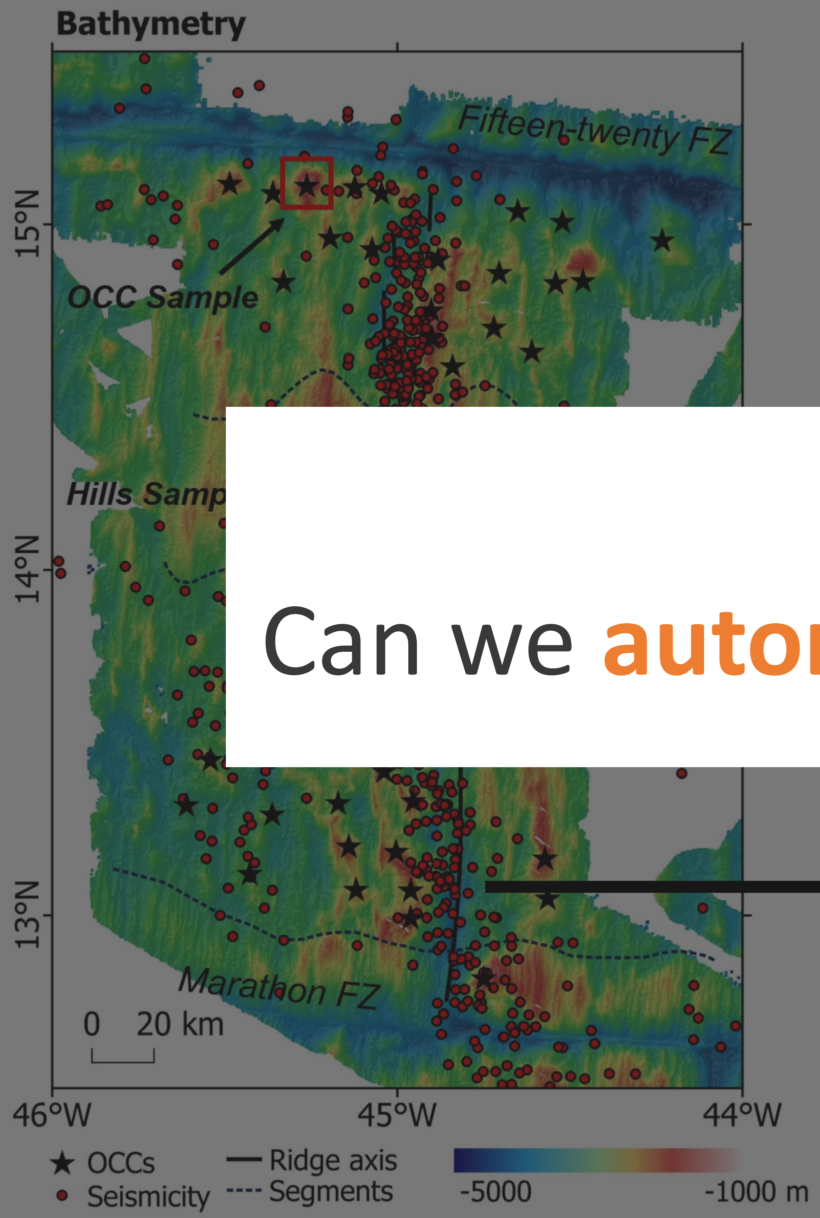

Adapted from Smith et al. (2008)

1. Introduction

Two distinct types of terrain at slow-spreading ridges:

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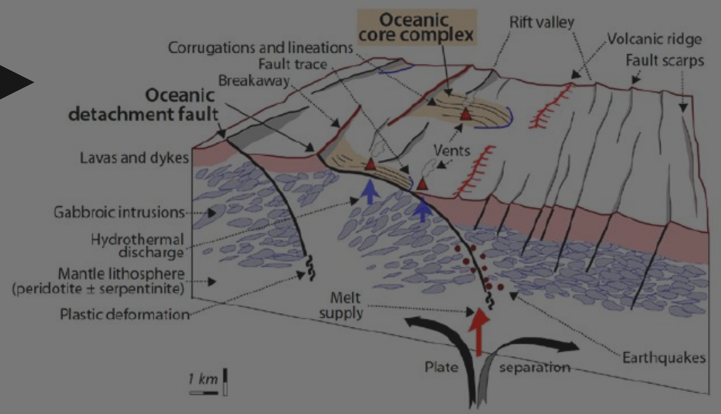
QUESTION:

Can we **automate** the terrain classification?



(Escartín & Canales, 2011)

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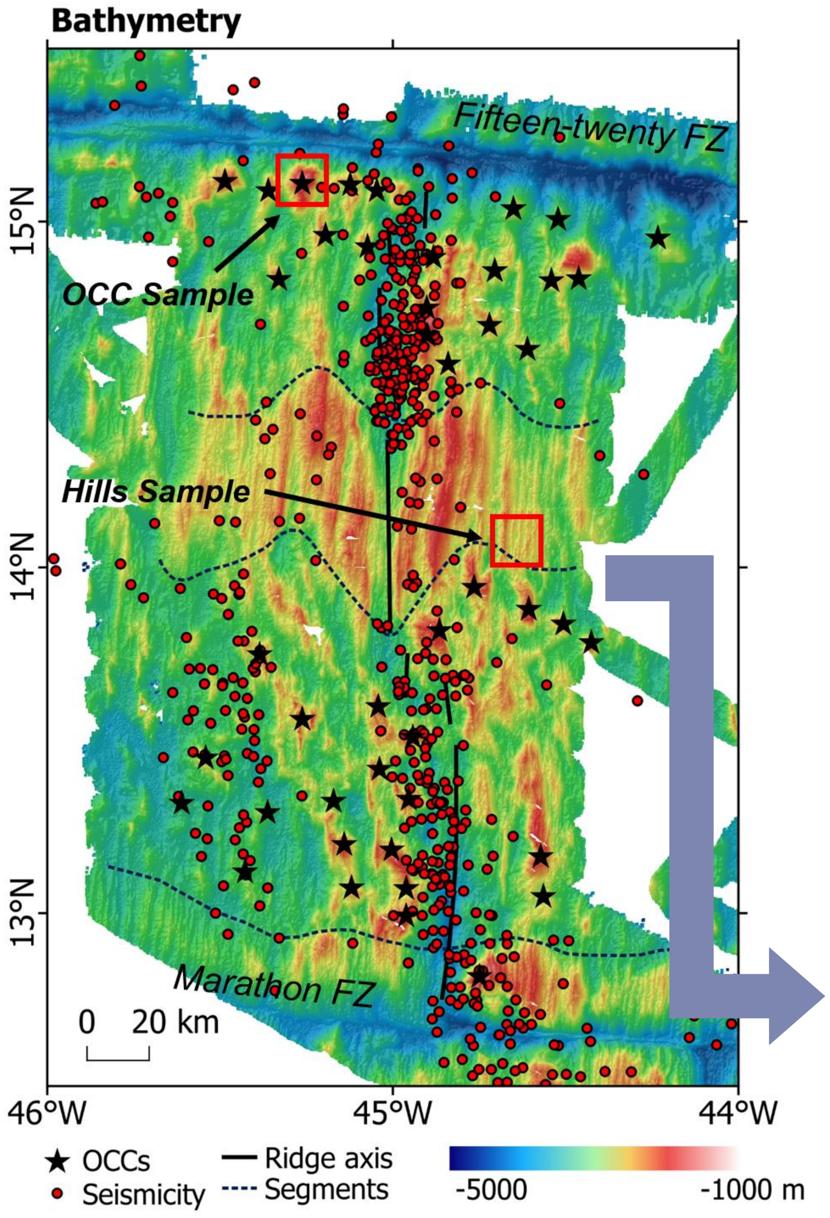


Adapted from Smith et al. (2008)

2. Methods

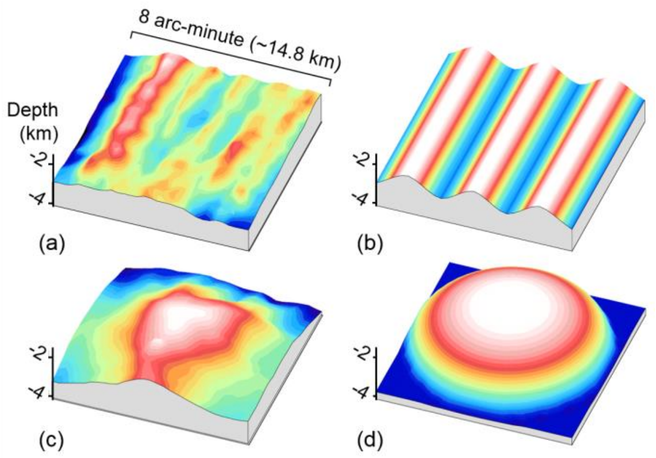
(1) **Sample** a patch of terrain from each terrain type

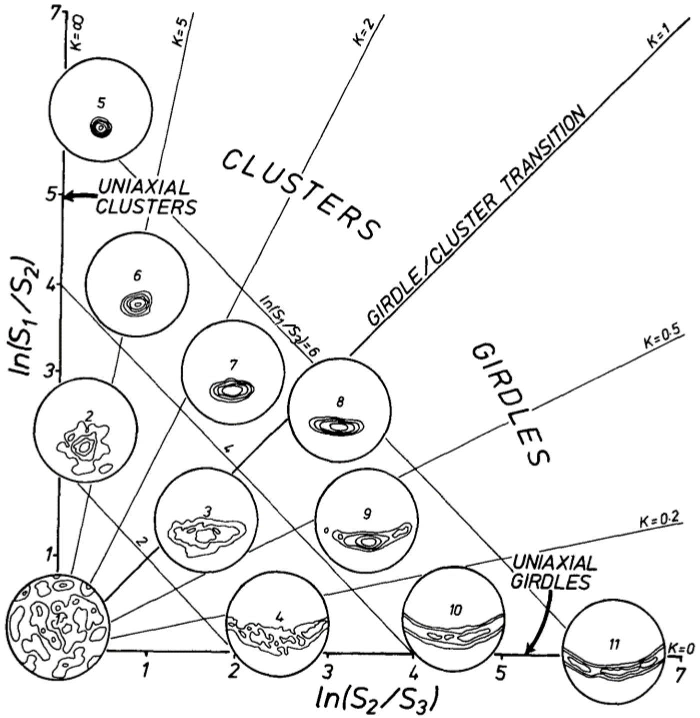
↓

(2) Build **synthetic models** that mimic both terrain

↓

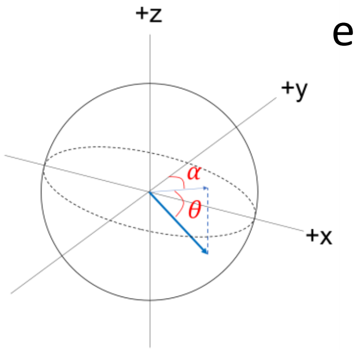
(3) Characterize based on its **shape, size,** and **directionality**



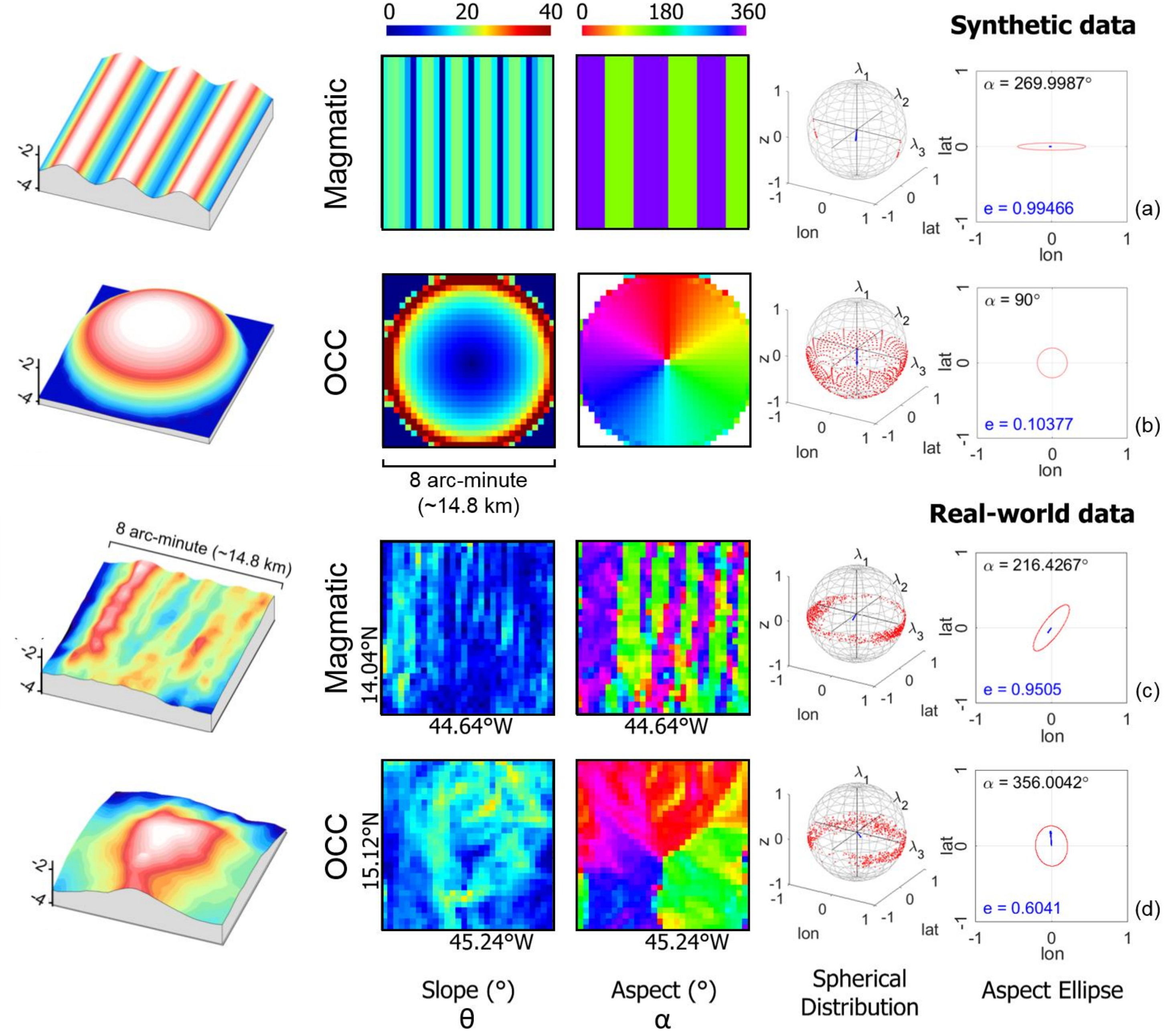


(Woodcock, 1977)

(5) Compute the eigenvalue **ratio**



(4) Analyze the **spherical distribution** by computing the **eigenvalues** ($\lambda_1, \lambda_2, \lambda_3$).



2. Methods (continued)

The **ratio** is defined by the eccentricity of the two **horizontal eigenvalues**.

Magmatic terrain

→ **High eccentricity** (bidirectional)

→ **Gentle slope** (short-lived faults)

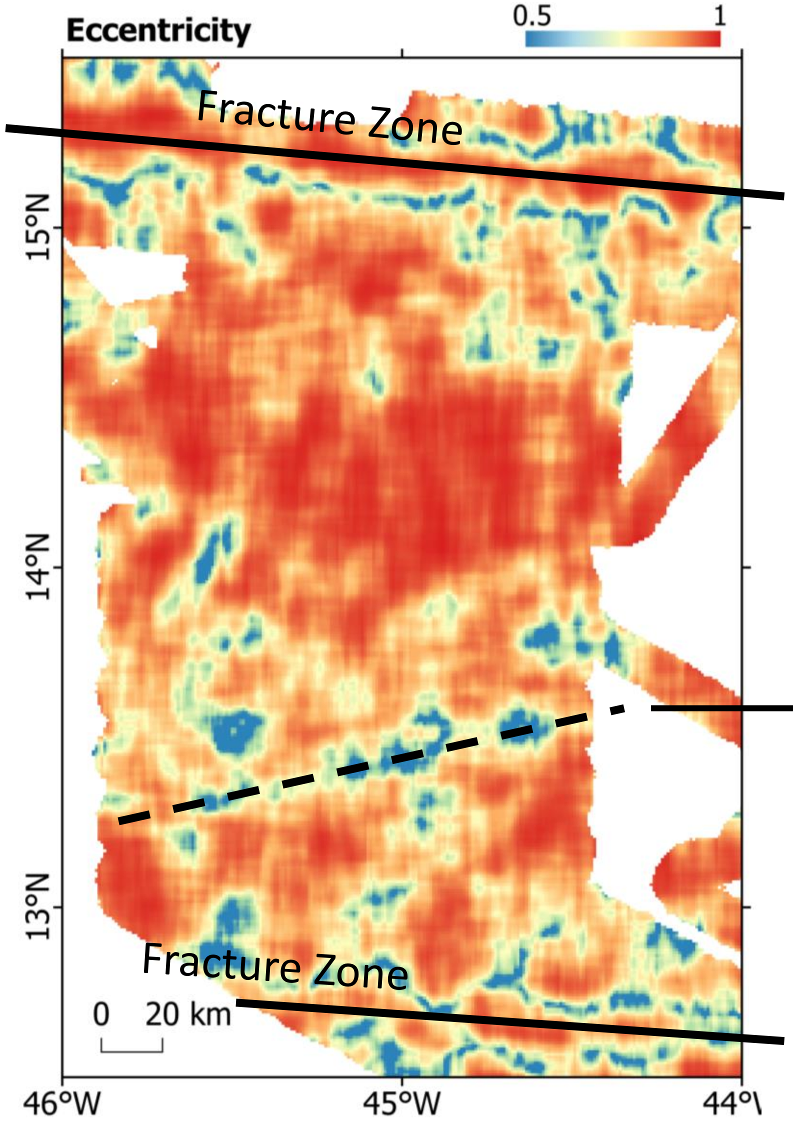
OCC/detachment terrain

→ **Low eccentricity** (omnidirectional)

→ **Steep slope** (long-lived faults)

Next step: Apply the computation to the whole grid with specified **window size**. Here we use 8’ or ~14.8 km following the **average size of OCCs**.

3. Results



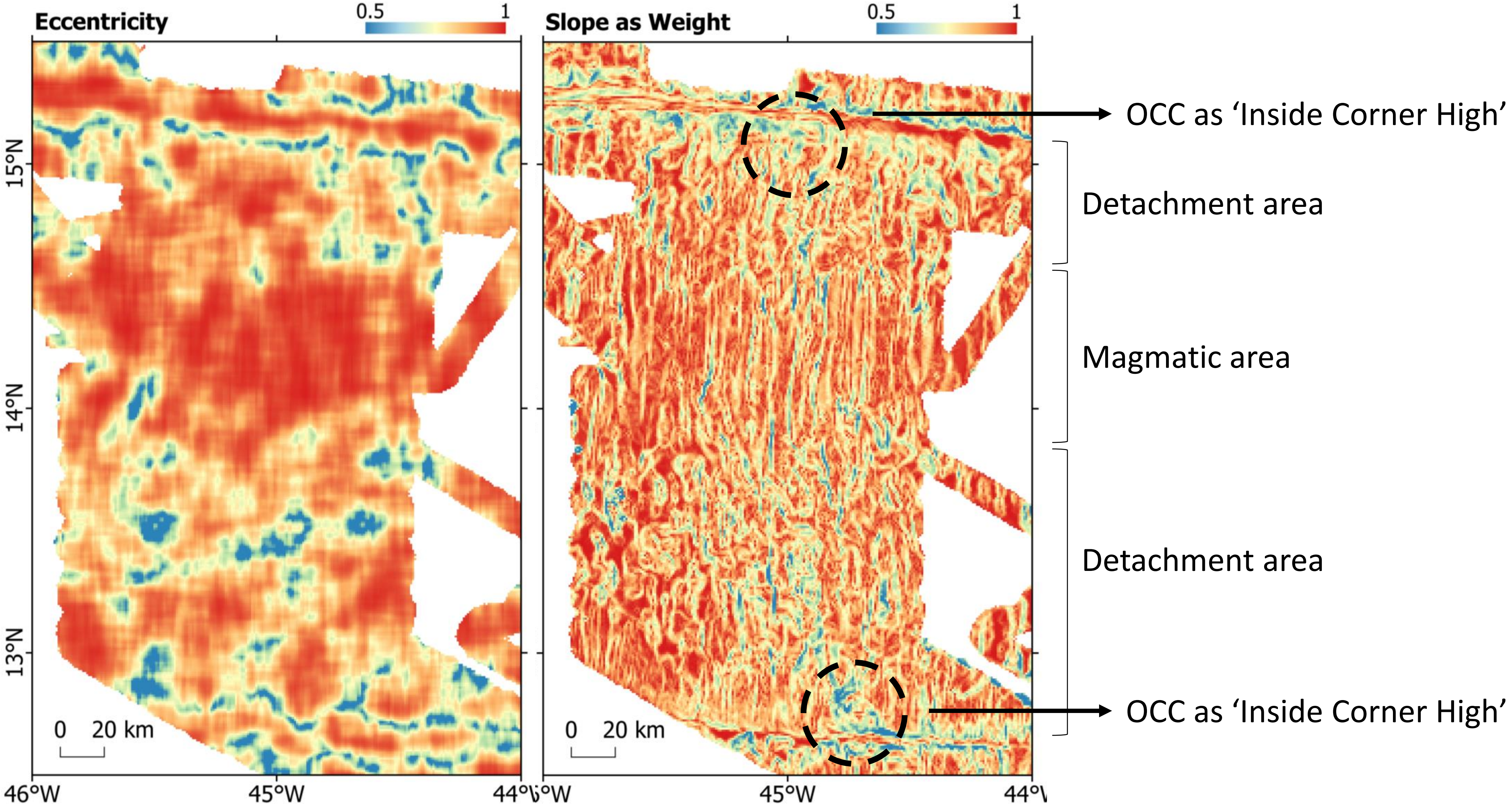
Detachment area

Magmatic area

Pattern that is not noticeable ‘by eyes’

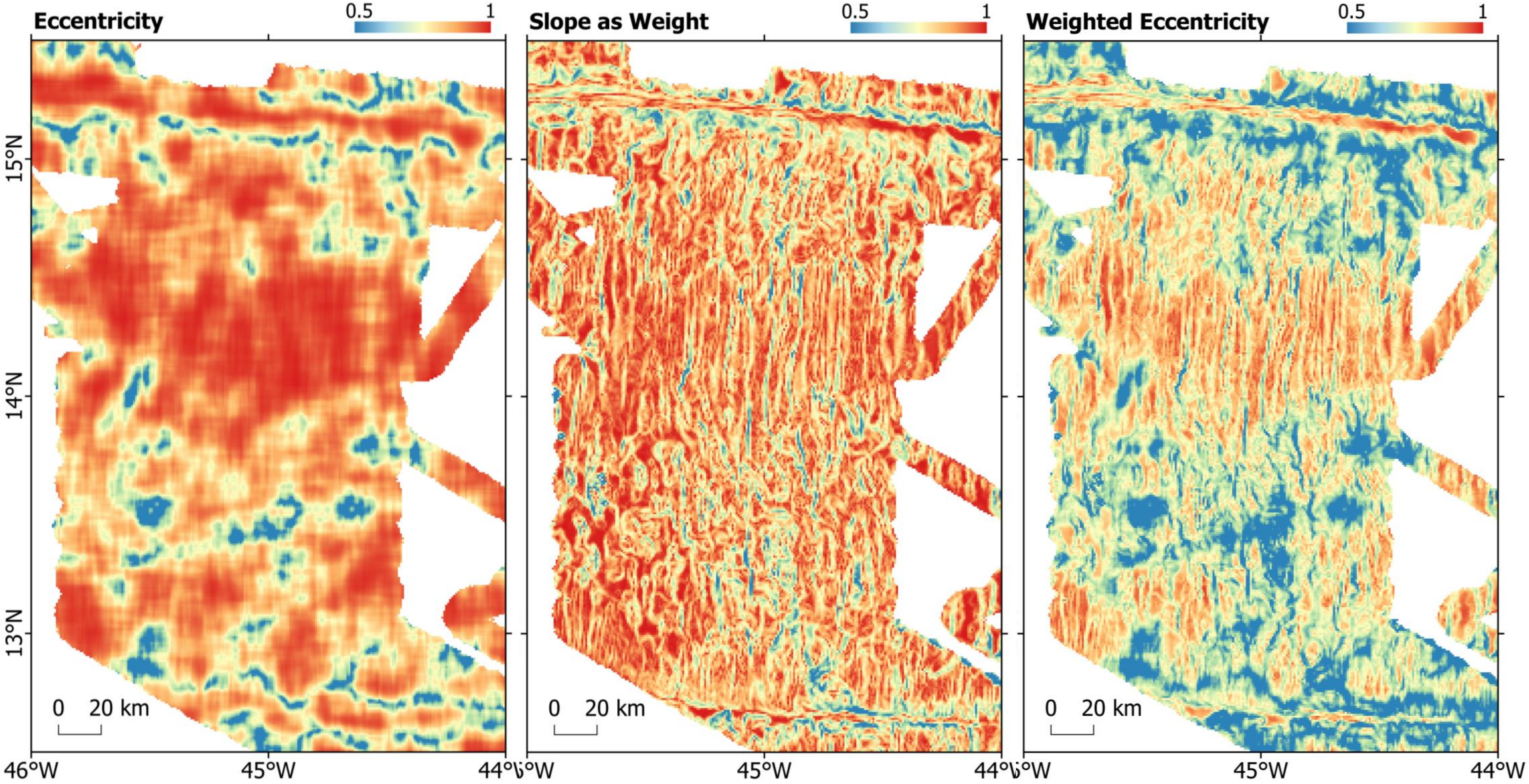
Detachment area

3. Results



Eccentricity
0.5
1
Slope as Weight
0.5
1
15°N
14°N
13°N
0 20 km
0 20 km
46°W
45°W
44°W
45°W
44°W
OCC as 'Inside Corner High'
Detachment area
Magmatic area
Detachment area
OCC as 'Inside Corner High'

3. Results


Eccentricity
0.5
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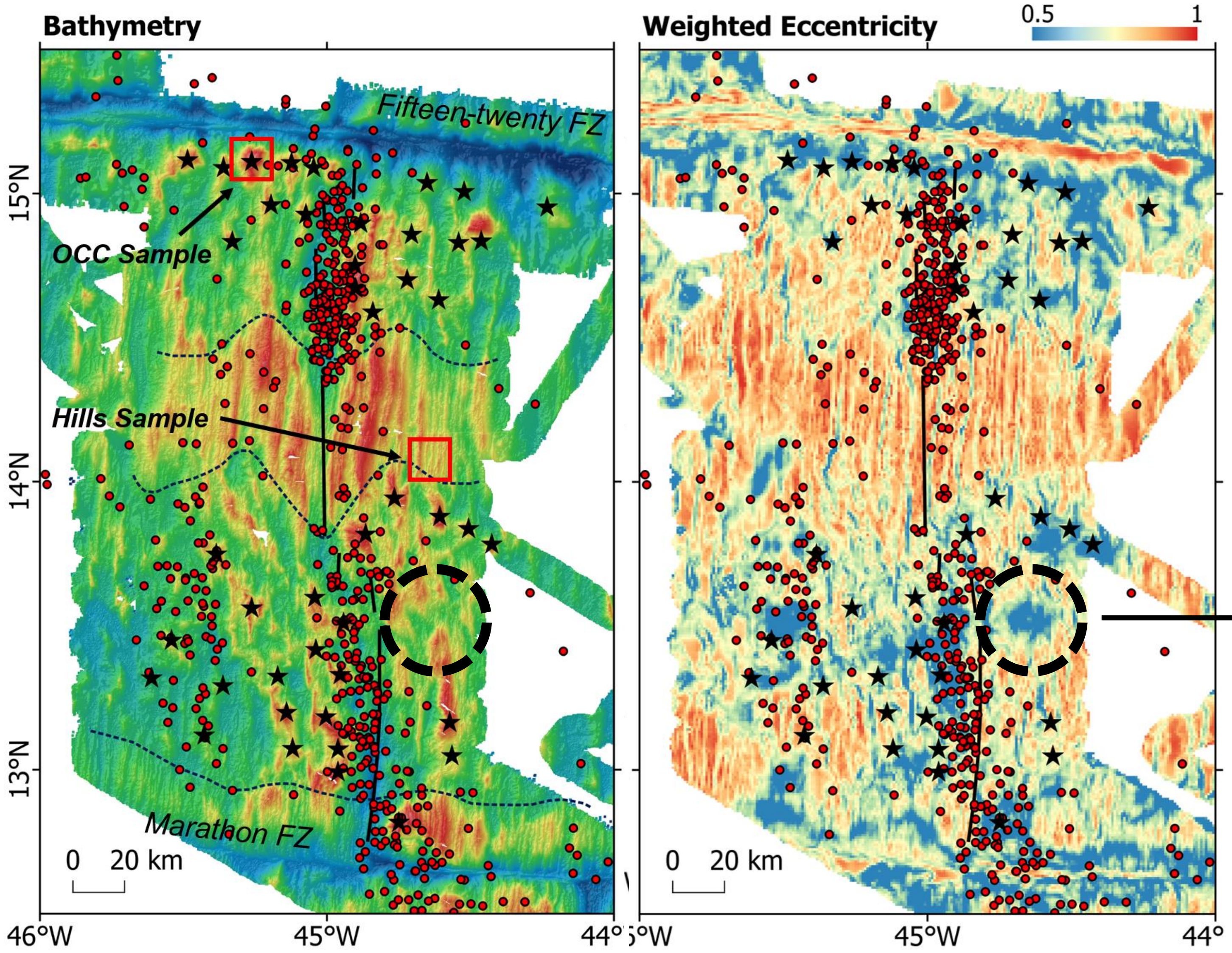
0.5
1
15°N
14°N
13°N
0 20 km
0 20 km
0 20 km
46°W
45°W
44°W
45°W
44°W
45°W
44°W

3. Results (comparison)



Detachment area

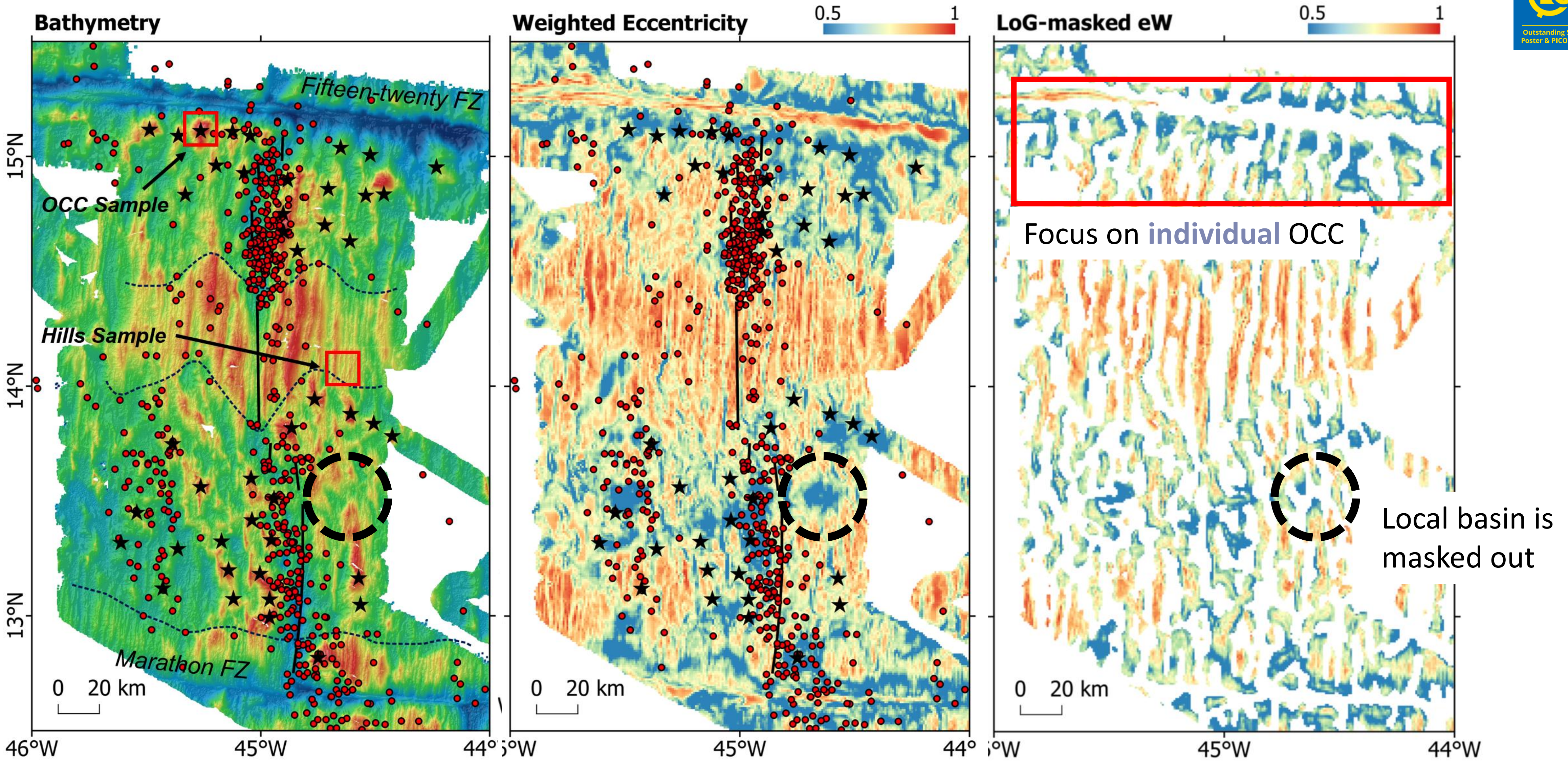
Magmatic area

The algorithm detects **OCC** and and **local basin** as similar feature

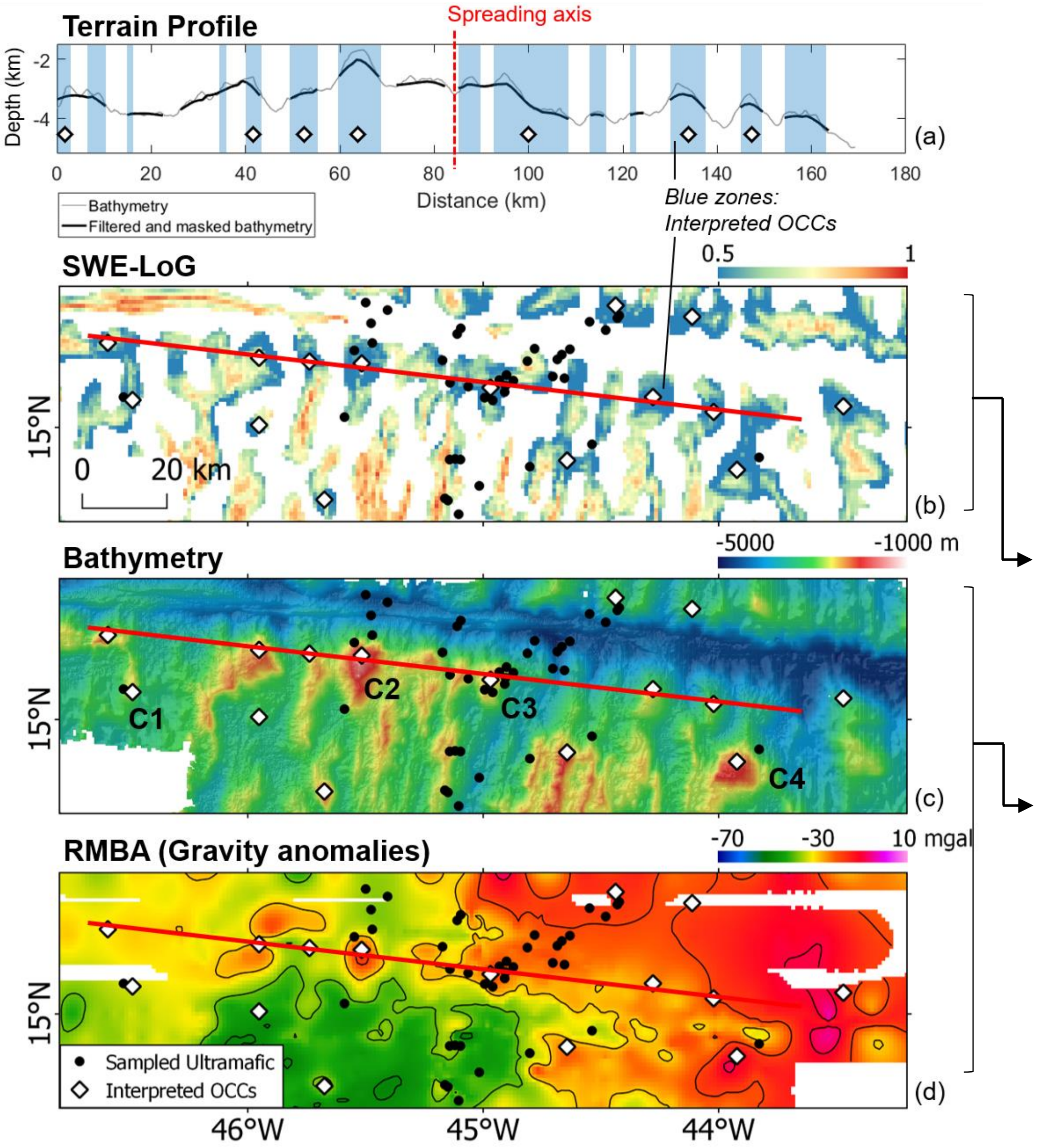
Detachment area

Next step: Filter the results based on **curvature** using Laplacian-of-Gaussian filter (**LoG**)

3. Results (masking)



4. Discussions



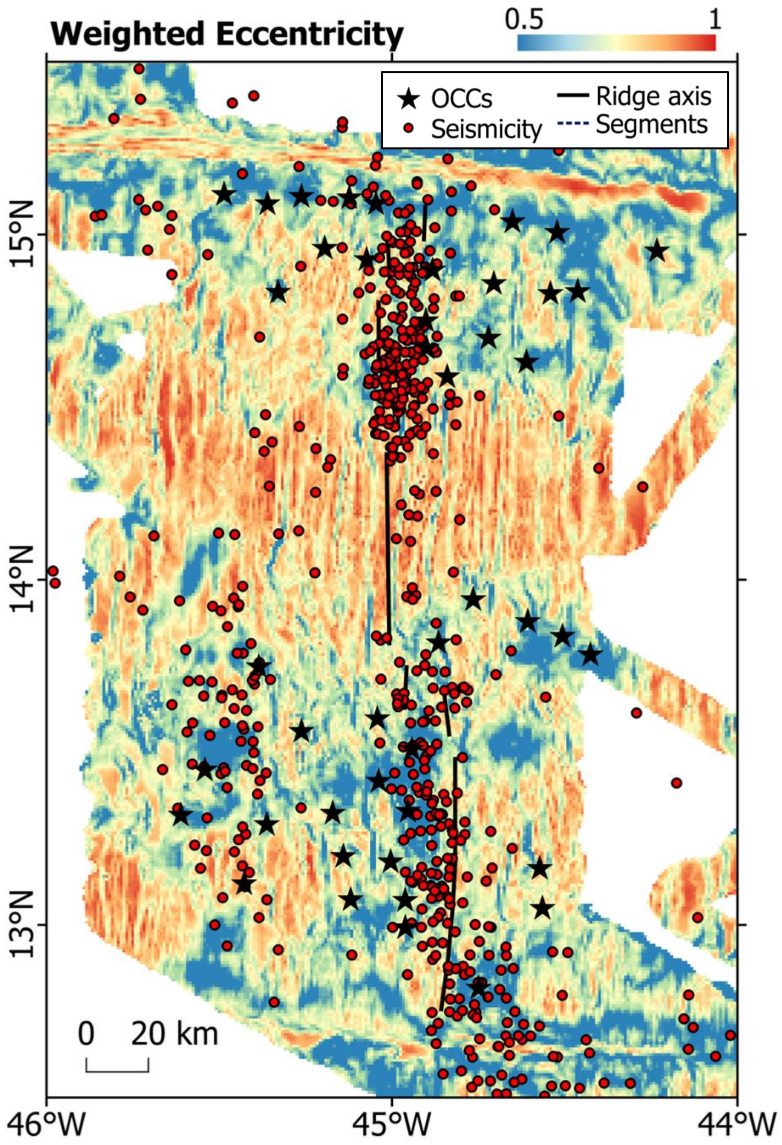
The terrain is classified based on its **eccentricity** and **slope**, hence the term:

Slope-Weighted Eccentricity (SWE)

OCCs identified with this method:

- Have **SWE** peak values of **0 - 0.65**
- Have **positive curvature** (domed structure)

Some identified OCCs (**C1** to **C4**) agree with **dredged ultramafic samples** from past cruises (e.g. Cannat et al., 1992) and with **high gravity anomalies** (Smith et al., 2008), indicating thin crust, enabling formation of detachment fault.



5. Conclusions

Slope-Weighted Eccentricity (SWE)

An **automatic terrain classification** algorithm based on the **shape, directionality, and curvature** of a gridded data.

The terrain is classified into:

- **Detachment terrain**, with SWE values of **0 - 0.65**;
- **Extended terrain**, with SWE values of **0.65 - 0.9**, and;
- **Magmatic terrain**, with SWE values of **0.9 - 1**.

These values are always on **fixed** range (0 < SWE < 1), hence it is **potentially re-applicable into grids other than bathymetry**.

The algorithm is being tested to gravity and magnetic grids.