Utrecht University

Kinematic reconstruction of deformation in SE Asia: unfolding Earth's largest Cenozoic orocline

X2.161

EGU General Assembly 2019

Eldert L. Advokaat [1,2] & Douwe J.J. van Hinsbergen [1]
[1] Department of Earth Sciences, Utrecht University, The Netherlands
[2] Department of Physical Geography, Utrecht University, The Netherlands

Introduction

SE Asia comprises a heterogenous assemblage of fragments derived from Cathaysia (Eurasia) in the north and Gondwana in the south. The Sundaland core was formed by accretion of Gondwana-derived fragments in the Late Triassic. More fragments accreted to Sundaland in the Cretaceous and Neogene.
SE Asia now hosts two strongly curved subduction zones: the Sunda trench with a 90° curvature and the Banda Arc with a 180° curvature (**figure 1**).
We restore these subduction zones to their original geometry at the timing of subduction initiation to study what mechanisms were responsible for orocline formation.

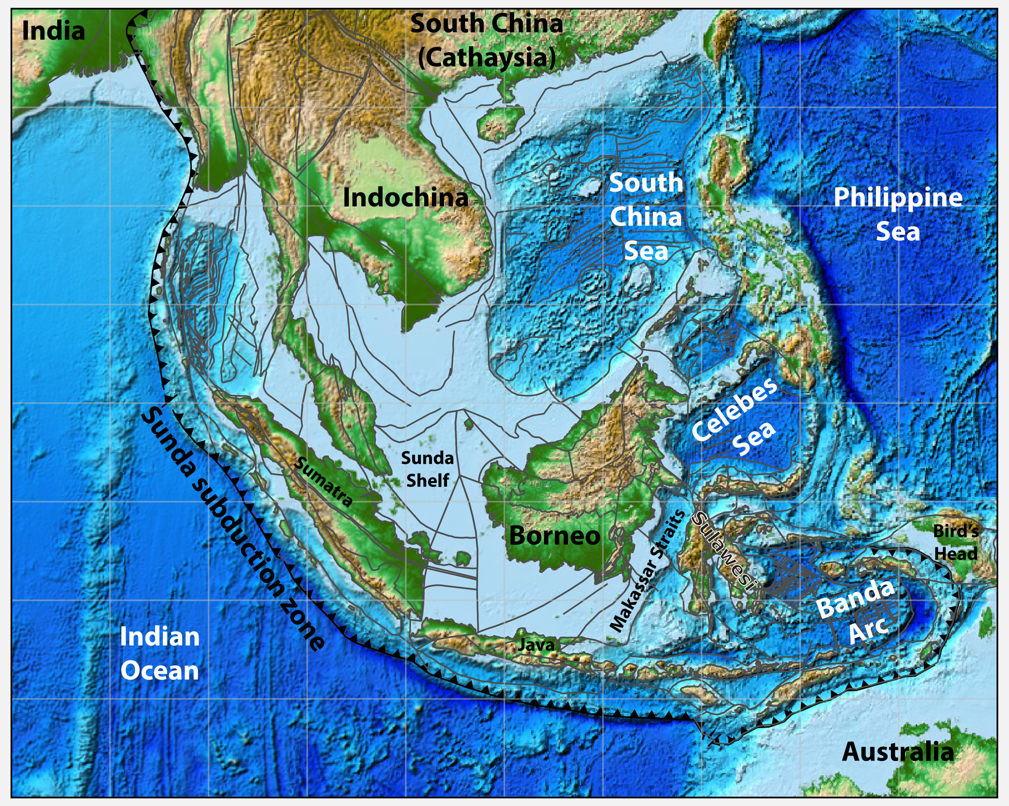


Figure 1.
Geographic map of SE Asia

Approach

Hierarchical reconstruction protocol:

1. marine magnetic anomalies
2. continental deformation
   a. extension
   b. strike-slip motion
   c. shortening
3. Geometric consistency

We test against and iteratively adjust the model to fit:

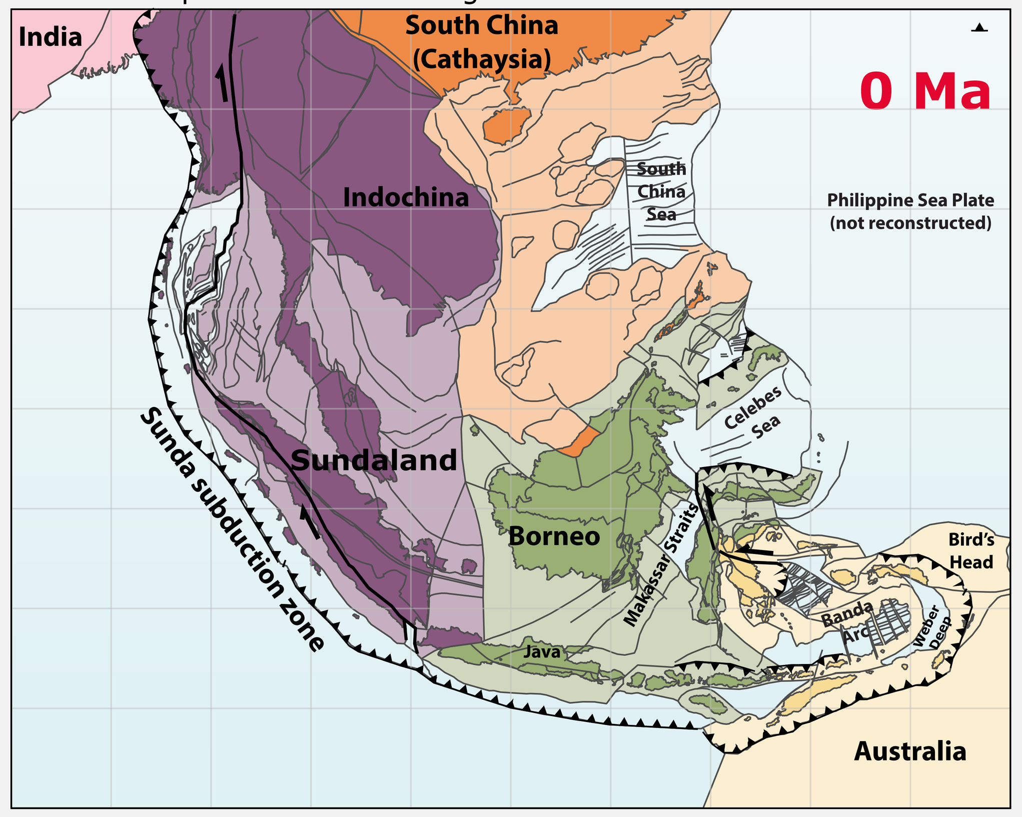
4. Paleomagnetically determined rotations
5. Paleomagnetically determined latitudes
6. Seismic tomography of the mantle

Datasets

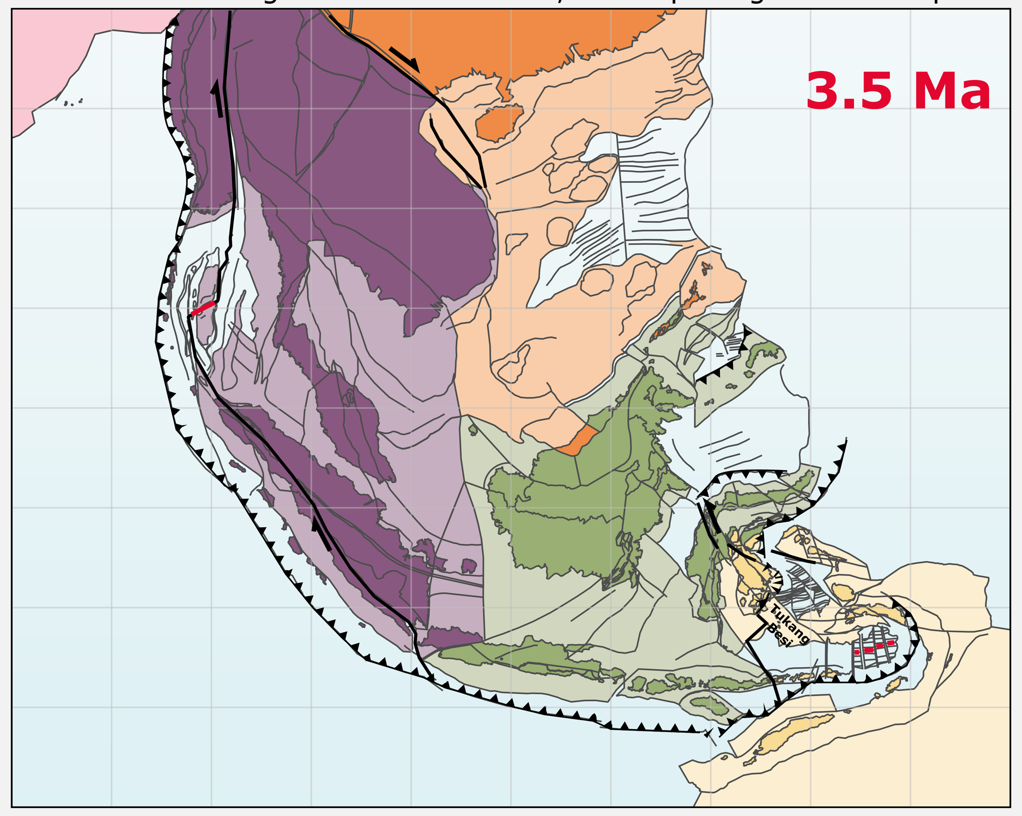
Plate circuit: Seton et al. (2012, ESR) with modifcations of DeMets et al. (2015, GJI)
Reference frames:
Paleomagnetic (Torsvik et al. 2012, ESR)
Moving hotspot (Doubrovine et al. 2012, JGR)
Regional reconstructions:
Tibet (van Hinsbergen et al. 2011, Tectonics; 2018, tectonophys)
South China (Replumaz & Tapponnier 2003, JGR)
Indochina (Li et al. 2017, ESR)
Sundaland and Borneo (Advokaat et al. 2018, Tectonics)

Reconstruction

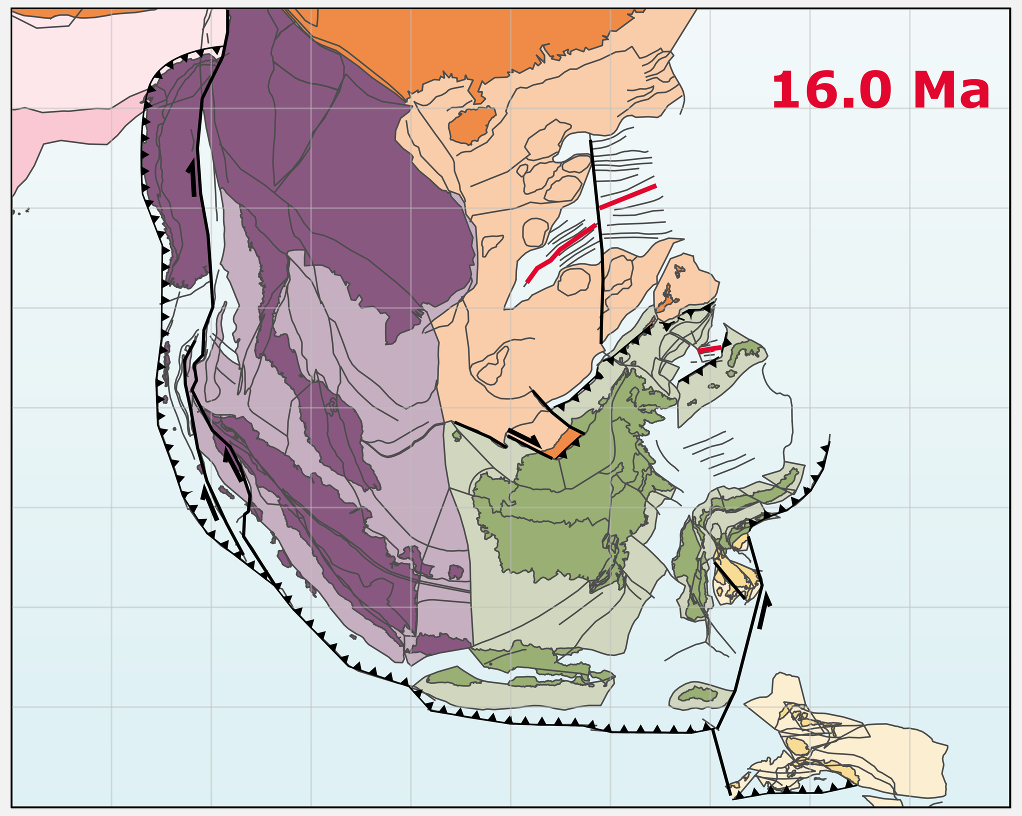
A) Present day (0 Ma)
Tectonic map of SE Asia showing active structures



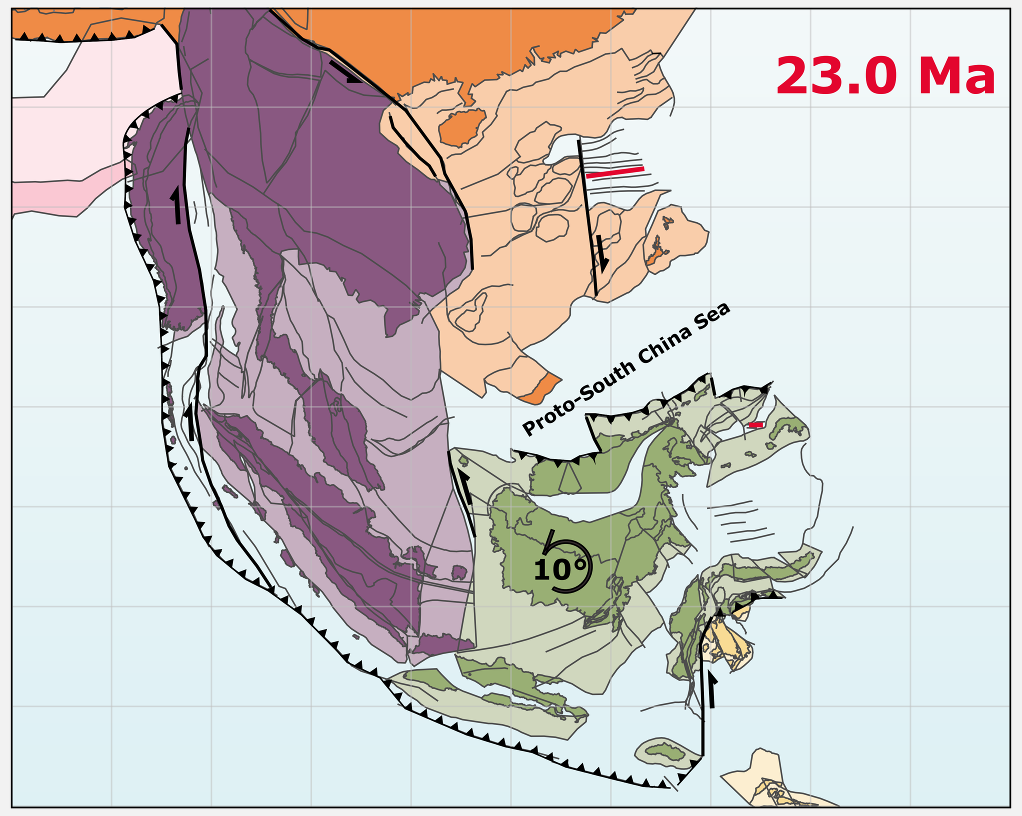
B) Base Zanclean (3.5 Ma)
Collision of Tukang-Besi with Sulawesi, start opening Weber Deep



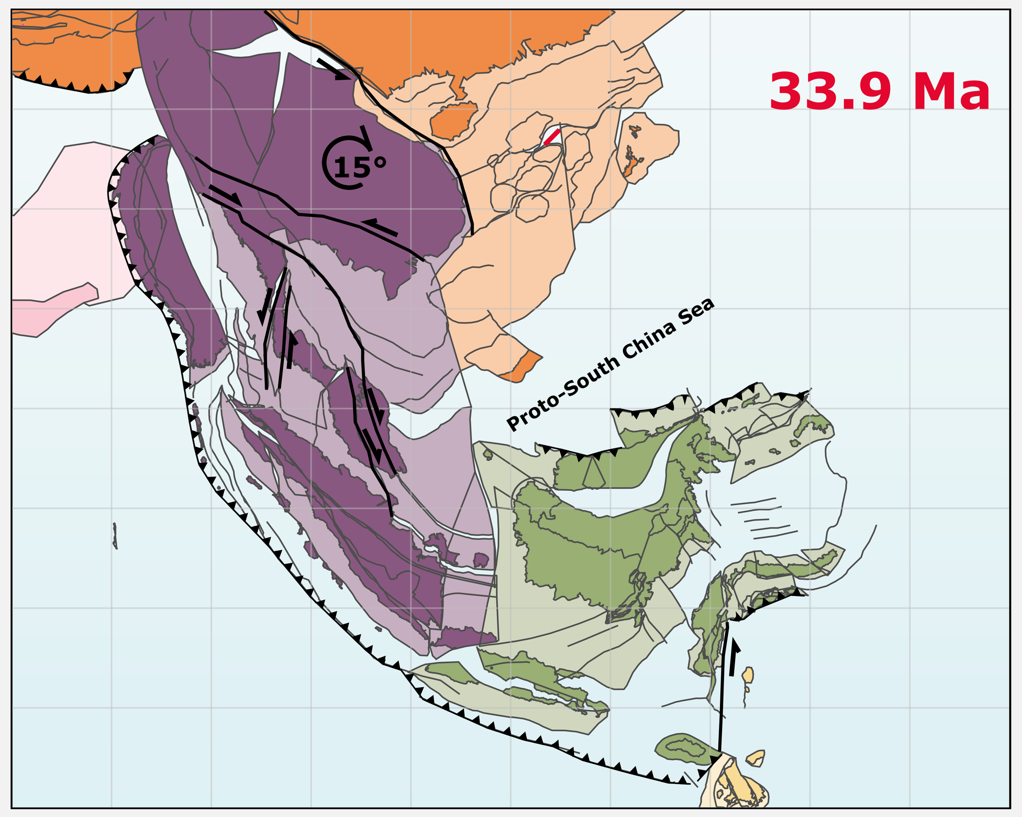
C) Base Langhian (16.0 Ma)
Closure of Proto-South China Sea, subduction initiation at Banda Arc



D) Base Aqutanian (23.0 Ma)
Collision of Sula Spur with Sulawesi, second rotation of Borneo



E) Base Rupelian (33.9 Ma)
End first Borneo rotation, Celebes Sea and Makassar Straits fully open



E) mid-Lutetian (C21; 45.72 Ma)
Subduction initation at Sunda trench and Sulawesi North Arm

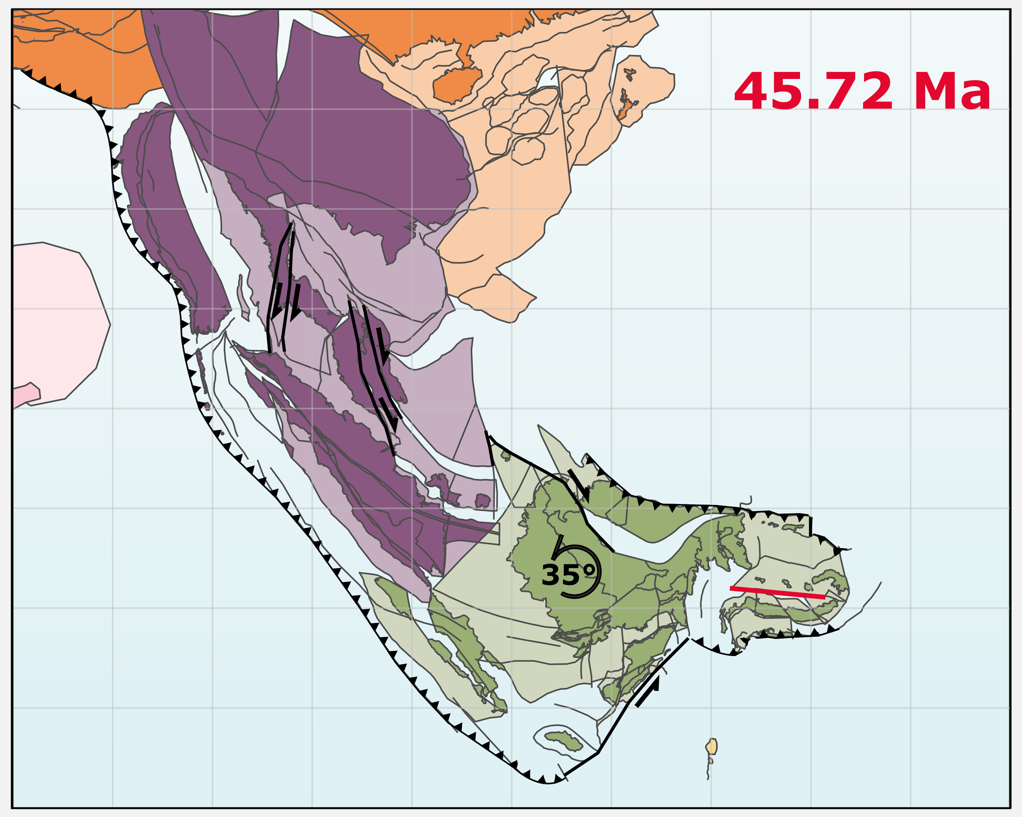


Figure 2A-F. **Kinematic reconstruction of SE Asia in the moving hotspot refrence frame of Doubrovine et al. (2012, ESR)**

Test against paleomagnetic data

We reconstruct two stages of counterclockwise rotation of Borneo, consistent with paleomagnetic data (**figure 3**).

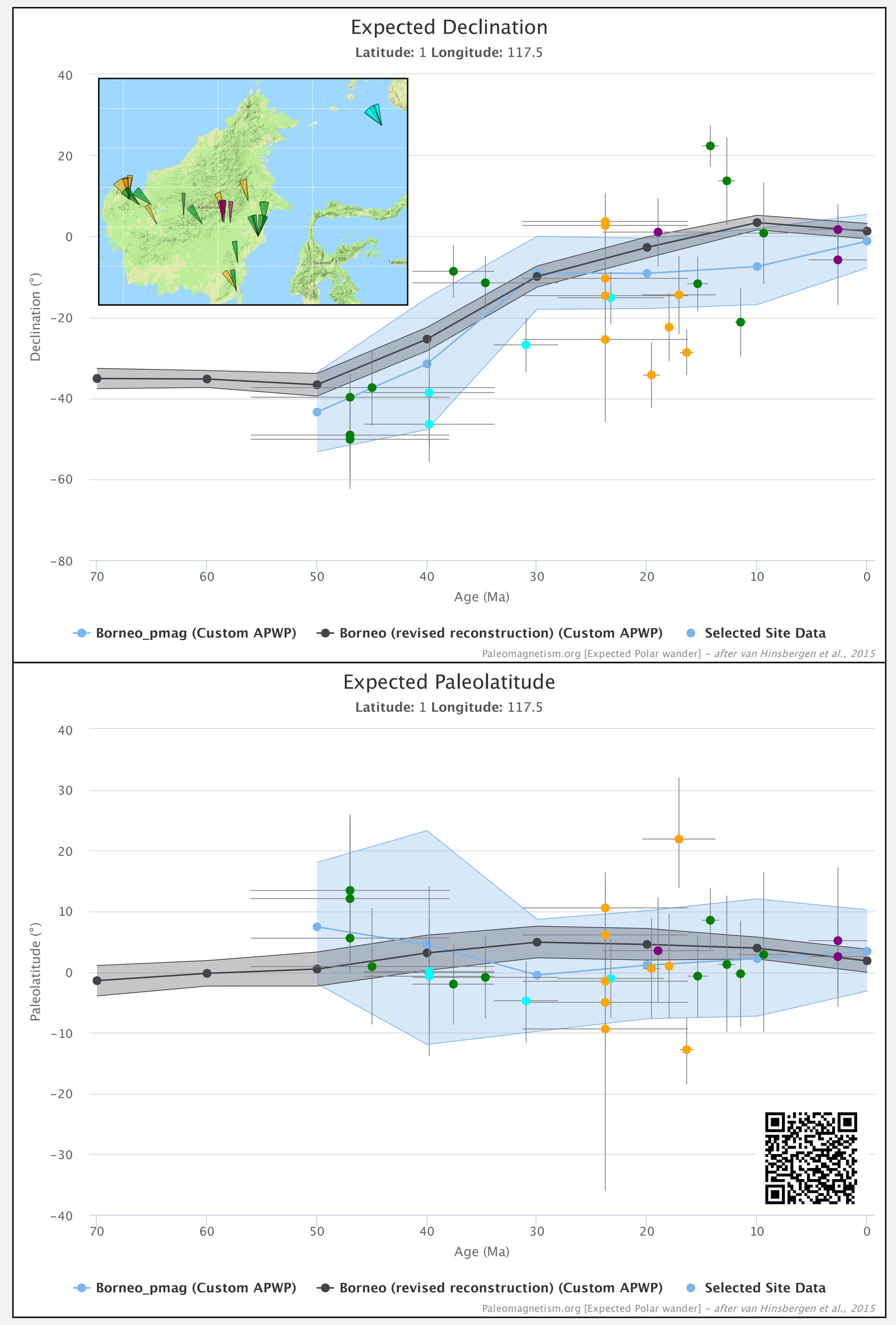


Figure 3.
Paleomagnetic data from Borneo (Advokaat et al. 2018, Tectonics) and the Celebes Sea (Shibuya et al. 1991, ODP)
green: tilt-corrected sedimentary sites; purple: tilt-corrected volcanic sites; orange: igneous rocks without tilt-correction; cyan: low-T overprint-corrected data from ODP core 770

Conclusions

1. **The Sunda and Banda subduction zones had a straight geometry when they formed**
2. **Two mechanisms of orocline formation:**
   - **The Sunda trench became curved through compression in the overriding plate.**
   - **The Banda arc became curved through eastward rollback of the Banda slab.**
3. **Most back-arc basins in eastern Indonesia formed above stationary trenches when the overriding plate moved away.**