

South Sandwich

Interpretation (based on geologic data, plate reconstructions, seismic tomography, geodynamic modelling)

The South Sandwich SZI event marked the start of the subduction of the South American plate westwards beneath the Scotia plate, giving rise to the South Sandwich subduction zone that remains active at present-day. The age of that SZI event remains debated, with estimates ranging from ~30 Ma to the Cretaceous (Eagles, 2010; Pearce et al., 2014) and, from the cross-disciplinary perspective, we estimate SZI to have occurred **between 39 and 29 Ma**. The type of SZI associated with the onset of South Sandwich subduction is interpreted as a **new destructive boundary** (after e.g., Pearce et al., 2014). South Sandwich subduction has, however, also been attributed to lateral propagation from the Endurance Collision Zone (Eagles, 2010) - in which case the event would not actually qualify as SZI, according to our definition. More broadly (on a larger scale), the South Sandwich SZI might be a consequence of subduction polarity reversal (Cramer and Tackley, 2014). In this interpretation, the South Sandwich SZI occurred as a subduction polarity reversal further back in time (between around 80-40 Ma) along one section of the previously intact South America-South Shetland subduction system (Cramer and Tackley, 2014), possibly by collision of the Chile ridge with the preexisting subduction trench (Barker, 2001). The South Sandwich SZI event might have coincided with a reconstructed acceleration of westward motion of the South America plate relative to the Africa plate (Barker 2001).

Direct evidence (based on direct measurements)

The oldest dated arc magmatic rocks associated directly to the South Sandwich system are calc-alkaline basalts, basaltic andesites and andesites dredged from the South Sandwich forearc, which have yielded K-Ar ages of 28.5 ± 0.9 Ma to 32.8 ± 3.2 Ma (Barker, 1995; Dalziel et al., 2013a). Similar Ar-Ar ages (28.5 ± 1.4 and 28.6 ± 1.0 Ma) have also been reported from basalts dredged from volcanic edifices in the Central Scotia Sea, which Dalziel et al. (2013a) and Pearce et al. (2014) have termed the "Ancestral South Sandwich Arc" (ASSA). Together, those ~33-28 Ma volcanic rocks indicate that a subduction-related magmatic arc must have been operating at least by 33 Ma, implying that SZI had occurred prior to that time. Geometric considerations also require that subduction was operating by the time the West Scotia Sea started spreading (as it outpaced the rate of separation between South America and Antarctica), which Pearce et al. (2014) have estimated to have begun by 32 ± 2 Ma on the basis of marine magnetic anomaly data. These observations thus place an upper age constraint of ~34 Ma on the timing of SZI.

The South Sandwich SZI is suggested to be of an Andean type in which the oldest lavas just postdate subduction initiation. This is due to the lack of crust (ophiolite) that might otherwise represent new lithosphere formed by subduction initiation rollback, as well as the lack of a boninitic component among the earliest lavas (Pearce et al., 2014). Pearce et al. (2014) also noted an isotopic signature of Pb and Hf enrichment among the oldest arc

volcanics, which they interpreted to reflect higher subduction temperatures associated with a hot mantle wedge that had not been cooled by prior subduction there.

Reconstruction (based on reference model by Müller et al., 2016, AREPS)

In the model of Müller et al. (2016), the South Sandwich SZI event occurs at 30 Ma. The southern half of the South Sandwich subduction zone exploits a pre-existing boundary where convergence was already occurring (labeled as the 'Endurance Collision Zone' in the model), whereas the northern half of the South Sandwich subduction zone develops away from active plate boundaries. There are no major plate tectonic reorganisation events associated with this region at this time, but after initiation of the South Sandwich subduction zone, the motion of the (then-enlarged) Central Scotia Sea plate (818) changes at 29 Ma.

Seismic tomography (based on Vote Maps of 10 seismic tomography models and the Atlas of the Underworld)

The South Sandwich subduction zone is represented by a west-dipping fast seismic anomaly connected to the surface and reaching a depth of 850 km (+/-200km) (van der Meer et al., 2018). Based on a vote map, seismic tomography models consistently predict a fast velocity anomaly until a depth of 1000 km. Some models cannot resolve the top of the anomaly, hence it is only visible below 400 km depth on the vote map.

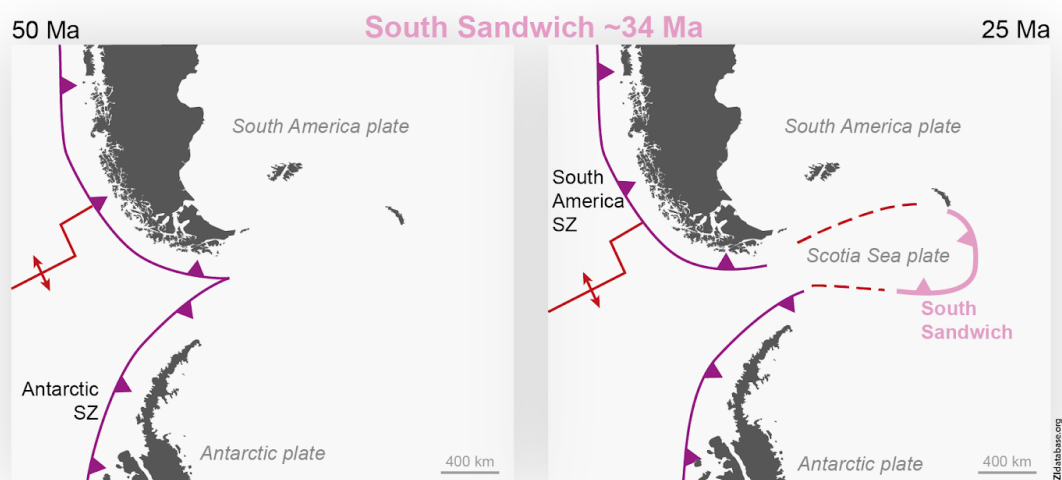


Figure. Schematic tectonic reconstruction of the South Sandwich SZI event (modified from Dalziel et al., 2013b). The arrival of the Chile ridge at the South America trench might have triggered a flip in subduction polarity, but the South Sandwich subduction zone is suggested to have initiated as a newly destructive boundary. Shown are the new subduction zone (pink line), other active subduction zones (solid purple lines), spreading ridges (solid red lines), and transform faults (red dashed lines).

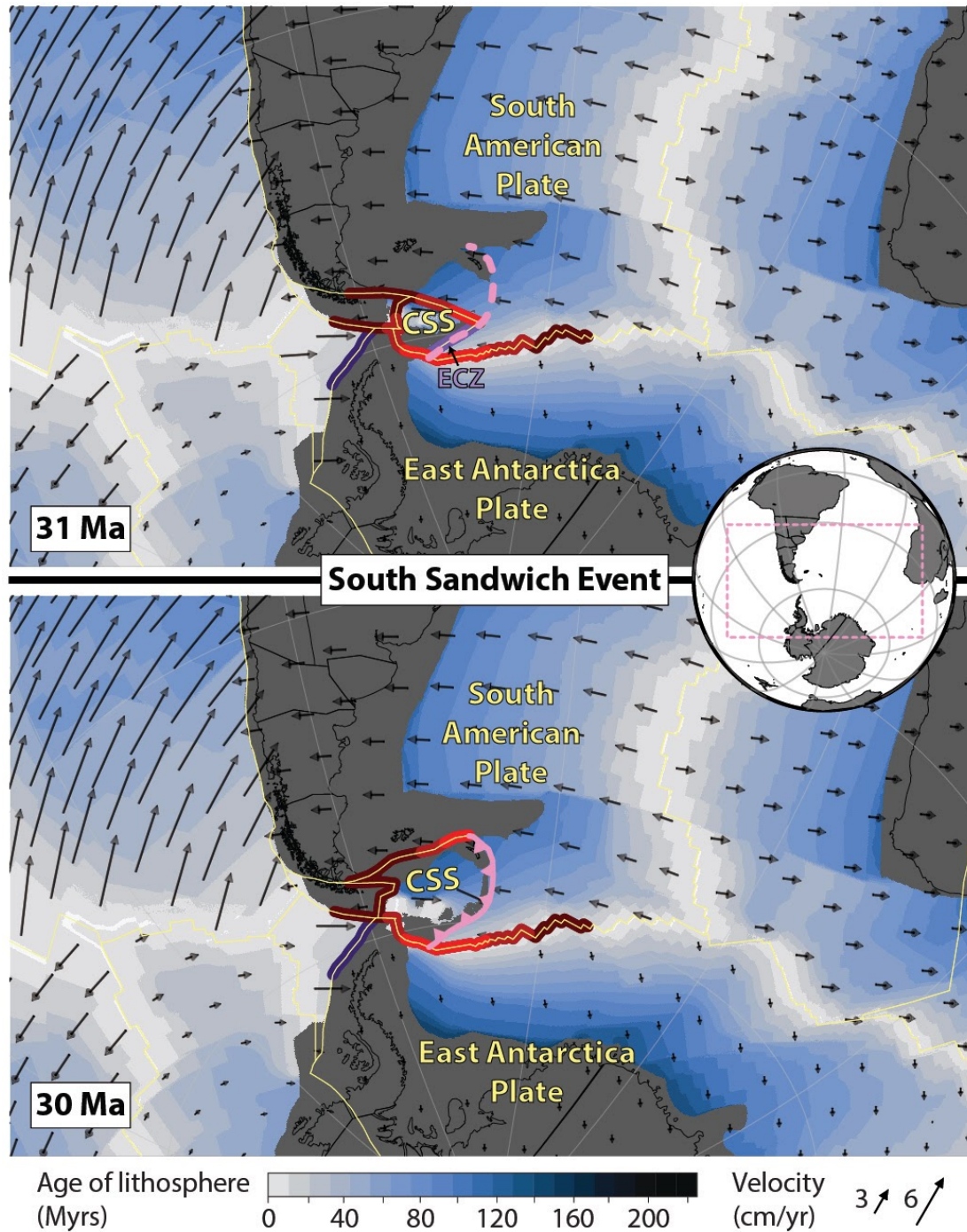


Figure. South Sandwich SZI event as reconstructed in the model of Müller et al. (2016). Pink dashed (solid with teeth) line shows the South Sandwich trench 1 Myr before (at) SZI time in the model. Purple (red) lines show segments of neighbouring subduction zones (ridges and transforms) that lie within some radius of the South Sandwich trench (pink line); the brightness of the colours reflects 3 different distance thresholds of 250, 500 and 1000 km. Abbreviations: CSS = Central Scotia Sea Plate; ECZ = Endurance Collision Zone.

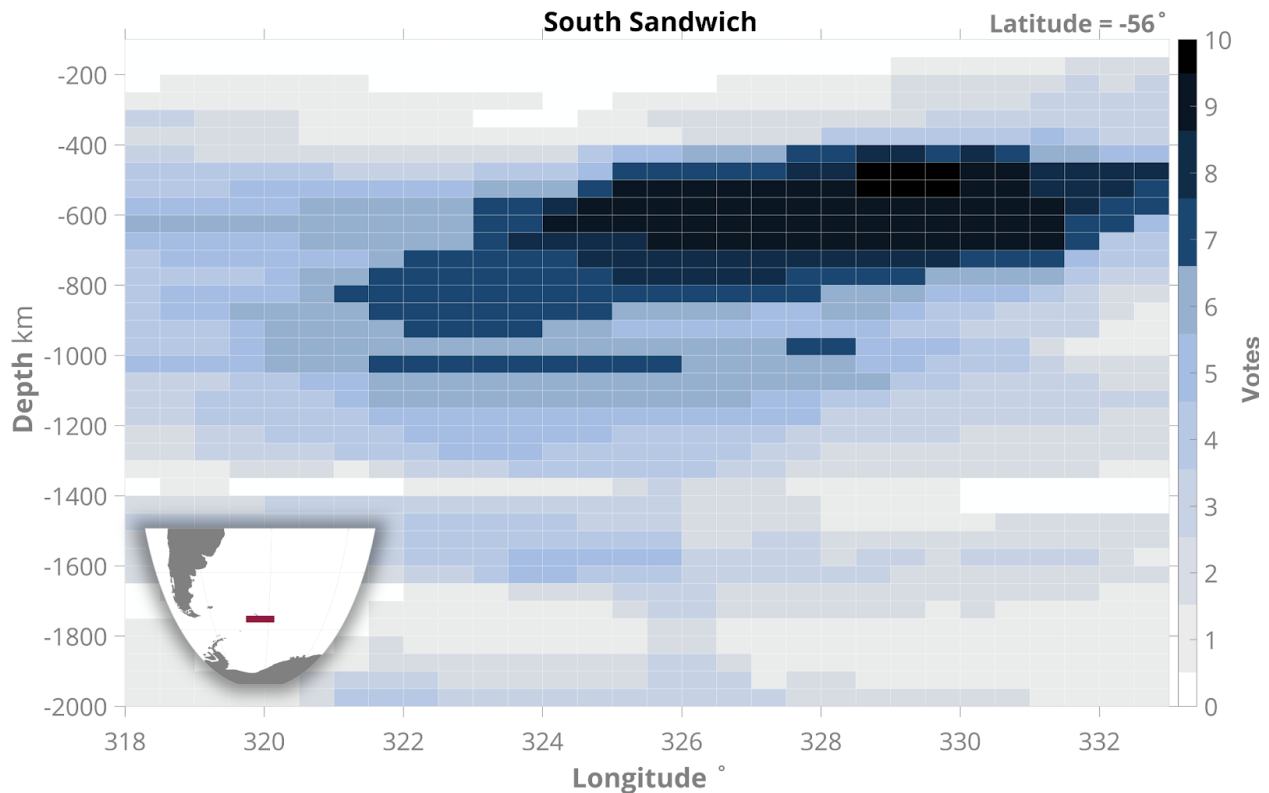


Figure. Seismic tomography VoteMap (Shephard et al., 2017) analysis of the South Sandwich SZI event.

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