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

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We produced the first geological map of the Scotia Sea area based on the available geophysical and geological data. Combining magnetic, Bouguer gravity anomaly and high-resolution bathymetric data with geological data from dredged samples allowed us to map lithologies and structural features in this mostly submerged and complex tectonic area. This geological map allowed us to integrate a very inter-disciplinary dataset, thereby reviewing the available data and addressing some of the still persisting geological challenges and controversies in the area.

One of the most important and persistent discussions is the nature and age of the Central Scotia Sea. We mapped this part of the Scotia Sea as basaltic-andesitic lithology partly covered by thick, oceanic sediments. This differs in lithology from the West and East Scotia Sea, which we mapped as a basaltic lithology. Based on our lithological map, its unusual thickness and the presence of the Ancestral South Sandwich Arc (ASSA, early Oligocene-late Miocene) we argue that Central Scotia Sea has an Eocene to earliest Oligocene age.

Cross-sections combining the geology, crustal structure and mantle tomography reveal high velocity anomalies and colder mantle material below the structural highs along the South Scotia Ridge (Terror Rise, Pirie Bank, Bruce Bank and Discovery Bank) and below the South Sandwich Islands. We interpreted those as the southern, stagnated part of the subducting slab of the South Sandwich Trench, following the geometry of Jane Basin and the currently active subducting slab at the South Sandwich Trench. Low velocity anomalies are observed below Drake Passage and the East Scotia Sea, which are interpreted as warmer toroidal mantle flow around the slab edges below the Chilean trench and the South Sandwich trench.

Based on our geological map and integrated cross-sections we propose a multi-phase evolution of the Scotia Sea area with Eocene or older oceanic crust for the Central Scotia Sea. A first wide-rift-phase initiated before 30 Ma in the West Scotia Ridge, Protector Basin, Dove Basin and Jane Basin either as a result of the diverging South American and Antarctic continents and/or due to subduction rollback that commenced soon after subduction initiation that eventually caused the ASSA to form. The first full spreading center developed in the West Scotia Sea, aided by the warmer toroidal mantle flow causing spreading to be abandoned in the other basins (~30 Ma). A second rift phase in the fore-arc, in between the ASSA and the South Sandwich trench (~20 Ma), initiated through a redistribution of far-field forces as a result of continuous trench retreat. The warmer toroidal mantle concentrated on the East Scotia Ridge resulting in the second spreading system (15 Ma), abandoning the West Scotia Ridge spreading system 6-10 Ma.

We show that it is possible to create a geological map in a very remote area with an extreme environment with the available geological and geophysical data. This new way of producing geological maps in the offshore domain provides a better insight into the geological history of geologically complex areas that are largely submerged.