Characteristics and evolution process of the tectonic regions in the Antarctic Sea as based on marine geophysical data

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The Antarctic Plate including the continental region is known to be classified into 11 tectonic regions. And also, the area south of 30˚S including the Antarctic Plate and its adjacent area is classified into more than 20 tectonic regions (Hayes, et al., 2009). Each tectonic region has experienced proper tectonic history and evolution process after the break-up of the Gondowanaland, cooling after the accretion of the oceanic crust at the mid-ocean ridges, subsidence of the seafloor due to the cooling and the oceanic sedimentation, and transition of the oceanic plate motion by the fluctuation of the Euler pole location for past 200 million years. The palaeo water depth of each era in each tectonic region during this period has been re-constructed by Hayes, et al. (2009).
The current study is proposed in order to clarify the uniqueness of each tectonic region in the Antarctic sea, the possible interaction with adjacent tectonic regions and its transition, and finally to estimate the driving force that led the evolution of each region. This study is based on analysis of marine geophysical data (seafloor topography, gravity, geomagnetic anomaly), seafloor age, total sediment thickness, etc., which are available at NCEI (National Centres for Environmental Information, NOAA) database. Marine geophysical data acquired by R/V MIRAI and Icebreaker SHIRASE are also examined in this study.
Since the new model of the present and past seafloor age was published (Müller et al., 2016) after the Hayes et al. (2009) work, palaeobathymetry of 25 and 50Ma was estimated at first through the assumed age-depth relationship based on the thermal contraction model of the plates:
depth = -2527.0 - 336.0 * (year^0.5) (depth in m, year in million years).
Both models (Hayes et al., 2009, and this work) are consistent as for 25 Ma. However, some discrepancies take place in the Pacific Ocean area between these models: an effect of a spreading ridge off the west coast of the southernmost area of South America is found to be missing in Hayes model.
NCEI provides two types of the global one-arc-minute-gridded topography/bathymetry data for both latitude and longitude: height/depth to the bedrock from the mean sea surface and that to the true surface including the glacier from the mean sea surface, as “ETOPO1-Bed” and “Etopo1-Ice”, respectively. According to the geophysical point of view, height/depth to the bedrock from the mean sea surface reduced by a correction of isostatic equilibrium by the effect of the extraction of the load of the glacier should be calculated and the result after that reduction should be mapped.
The distribution of seafloor age, spreading asymmetry, full spreading rate and spreading obliquity based on the model of Agegrid-2000 (Müller et al., 2020) is available. According to this model, the present slow spreading ridge (Mid Atlantic Ridge) shows that the spreading rate changed drastically around 60Ma from 50 mm/yr to 20 mm/yr. After that the spreading rate changed gradually from 20 to 40 mm/yr. On the other hand, the spreading rate is almost constant at the AAD (Australia Antarctic Discordance) on the present intermediate spreading ridge (South East Indian Ridge) and the rate is about 60 mm/yr. Note that the timing of the formation of the South West Indian Ridge corresponds to the change of the spreading rate at the Mid-Atlantic Ridge followed by the split between the Antarctica and Australia. As for the East Pacific Rise, the seafloor spreading rate drastically offset along the Eltanin fracture zone. The rate is over 150 mm/yr north of the FZ while that of south is less of 90 mm/yr.
Total sediment thickness model based on the NCEI database of Globsed Ver.2 is available. Note that the sediment thickness is higher in the Indian Ocean and the Atlantic off South American Continent, although the condition around the Antarctica should be almost constant as for the sedimentation. The

sedimentation rate distribution calculated by the sediment thickness and the seafloor age shows similar tendency.

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