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A Rocas Verdes Model for the Evolution of Bransfield Strait

Aijun Ren, Qingmin Jin and Guangfu Xing

Antarctic Research Center, Nanjing Institute of Geology and Mineral Resources,
534 East Zhongshan Road, Nanjing 210016, P.R. China

Bransfield Strait (BS), between the South Shetland Islands (SSI) and the northern of Antarctic Peninsula (AP), is a Cenozoic back arc basin with an asymmetric profile (Gamboa *et al.*, 1994). Geological survey there have long been carried out, however, a detailed interpretation of the basin's tectonic evolution is still a matter of debate (e.g., Kim *et al.*, 1992; Barker *et al.*, 1994). Since 1986, the authors have fulfilled 3 times investigations in SSI and southern Andes (SA) and obtained lots of stratigraphic data. By further summarizing the evolution of Rocas Verdes (RV), a typical late Mesozoic back arc basin formed in SA (Suarez and Pettigrew, 1976; Ren *et al.*, 1993), and combining with some data related to the area of BS in literatures, we correlated the two areas, and give our support to the viewpoint that BS is a back arc basin proposed by many workers (e.g., Kim *et al.*, 1992; Ren *et al.*, 1993; Ren and Jin, 1994; Bochu, 1994). In addition, we, for the first time, envisage a new model, i.e., RV model for the evolution of BS in this compilation. According to the model, BS and RV basin share a very similar evolution model and process. The former can be regarded as a reapperance of the latter in Antarctica.

Rocks related to RV basin opening were firstly divided by Surez and Pettigrew (1976) into 3 strato-tectonic belts of which consist island-arc, marginal basin and shelf assemblage. We (Ren *et al.*, 1993; Ren and Jin, 1994) revised the division and presented a new one that is composed of 4 tectonic belts, i.e., CA, IA, BB and OC belt. Each of the belts coincides with a certain kind of tectonic environment, such as CA belt is consistent with Volcano-magmatic arc formed on continental margin (Continental arc); IA belt to island arc; BB belt to back arc basin and OC belt to T-type mid-oceanic ridge or oceanic crust. Rocks related to BS opening can also be divided into 4 tectonic belts closely corresponding to those related to RV basin (Table 1).

Considering that tectonic belts related to BS and RV basin are comparble, and that rock a ssemblages there are under control of similar tectonic environment, we proposed that BS opening takes after that of RV basin (Fig. 1).

As shown in the figure, SA (left) sufferred east-dipping subduction of Pacific Plate during middle of earlier and late Jurassic, forming a volcano-magmatic arc that is none other than CA belt on the west margin of the continent. The belt is represented by Tobifera Formation and rests unconformably on pre-Jurassic metamorphic basement. At about 110 Ma ago, the formed CA belt and underlying basement separated into 2 parts due to incipient rift of RV basin under where mantle-derived magma and probably mantle itself moved upward. Of the 2 parts, the western one, smaller in size, migrated westward (old direction) and underwent subduction continuously, forming a new island arc named Hardy Arc. Those newly-formed volcanic rocks on the arc are underlain unconformably by rocks separated from previous CA belt, hence those rocks including basement and a small part of Tobifera Formation act as the roots for the new island arc. The easterm one, however, sufferred no subduction that after, thus no post-rift subduction-related rocks occurred, moreover, the part bacame a remnant continental arc as a small part of early CA belt and basement had drifted away. Between the 2 parts, there was RV basin that opened, widened and deepened increasingly along with the formation of Hardy Arc, in addition, a T-type mid-oceanic ridge represented by Tortuga Complex developed in the basin. At about 90 Ma, RV basin closed.

Comparing the evolution of BS with that of RV basin, we can find that the 2 basins' evolution are alike. AP,

Table 1. Division of tectonic belt in the area of BS and SA.

area	tectonic belt	example	time span	main composition
southern Andes	CA	Tobifera	~11.0Ma	andesitic-rhylitic lava, tuff with intercalations of basaltic lava and less amount of volcanic breccia, conglomerate
	IA	Hardy	110~90Ma	gently folded volcaniclastic rocks and terrestrial congiomerate
	BB	Rocas verdes	110~90Ma	volcaniclastic turbidites of Yahgan Formation, From the lower part to the upper part, congiomerate, sandstone, siltstone, volcanoclastic rocks and shale occur
	OC	Tortuga	?~90Ma	ophiolite complex constituted by trectolite-gabbro-pillow lava-sheeted dyke swarms
Antarctica	CA	Antarctic Peninsula	~26-22Ma	mid-late Jurassic to lower Tertiary subduction-related igneous rocks
	IA	South Shetland Islands	26-22Ma~	basalt, basaltic andesite, andesite, andesitic lave, tuff and granite
	BB	Bransfield Strait	26-22Ma~	fine-grained clastic sediments with large-sized fragments of tillite, volcanics (volcaniclastic turbidite?)
	OC	Deception-Bridgeman line	<26-22Ma	extension-related volcanic rocks with transitional characteristics between alkaline and calc-alkaline series

*Data from Ren *et al.* (1993), Ren and Jin (1994), Suarez and Pettigrew (1976), Birkenmajer (1992) and Weaver *et al.* (1982).

SSI, BS and Deception-Bridgeman line correspond to Tobifera Formation, Hardy Arc, RV basin and Tortuga Complex, respectively. As for AP, it together with underlying pre-Jurassic basement like Tobifera Formation and associated basement, serves as CA belt started to separate during 26-22 Ma (Birkenmajer, 1992) caused by initial rift of BS, which resulted in westward migration of the western part (SSl), also smaller in size, of separated CA belt. Just as have occurred in SA except Deception-Bridgeman line, the part was subducted by Pacific (Phoenix) Plate successively, forming SSI Arc whose roots is also constituted by pre-Jurassic basement (e.g., metamorphic rocks on Smith and Livingston islands) and pre-late Oligocene, subduction-related igneous rocks (e.g., Mesozoic and lower Cenozoic volcanic rocks on SSI) drifted from early CA celt. The other part (AP), became a remnant are and BS became a back arc extensional basin. Deception-Bridgeman line shows much less ridge and oceanic affinities compared with Tortuga Complex, which indicates the most obvious difference between BS and RV basin, and has been cited by Birkenmajer (1992) and Barker *et al.* (1994) as an evidence to support BS' intracontinental origin. However, Weaver *et al.* (1982) suggested that rocks formed on the line are back arc extension related. Araneda and Gonzalez-Ferran (1992) argued that the line is in fact the rift zone of BS. The authors believe that BS being still in its teenager or back arc sperading ceased too much early can be introduced to explain the above mentioned difference and Birkenmajer's and Barker's.

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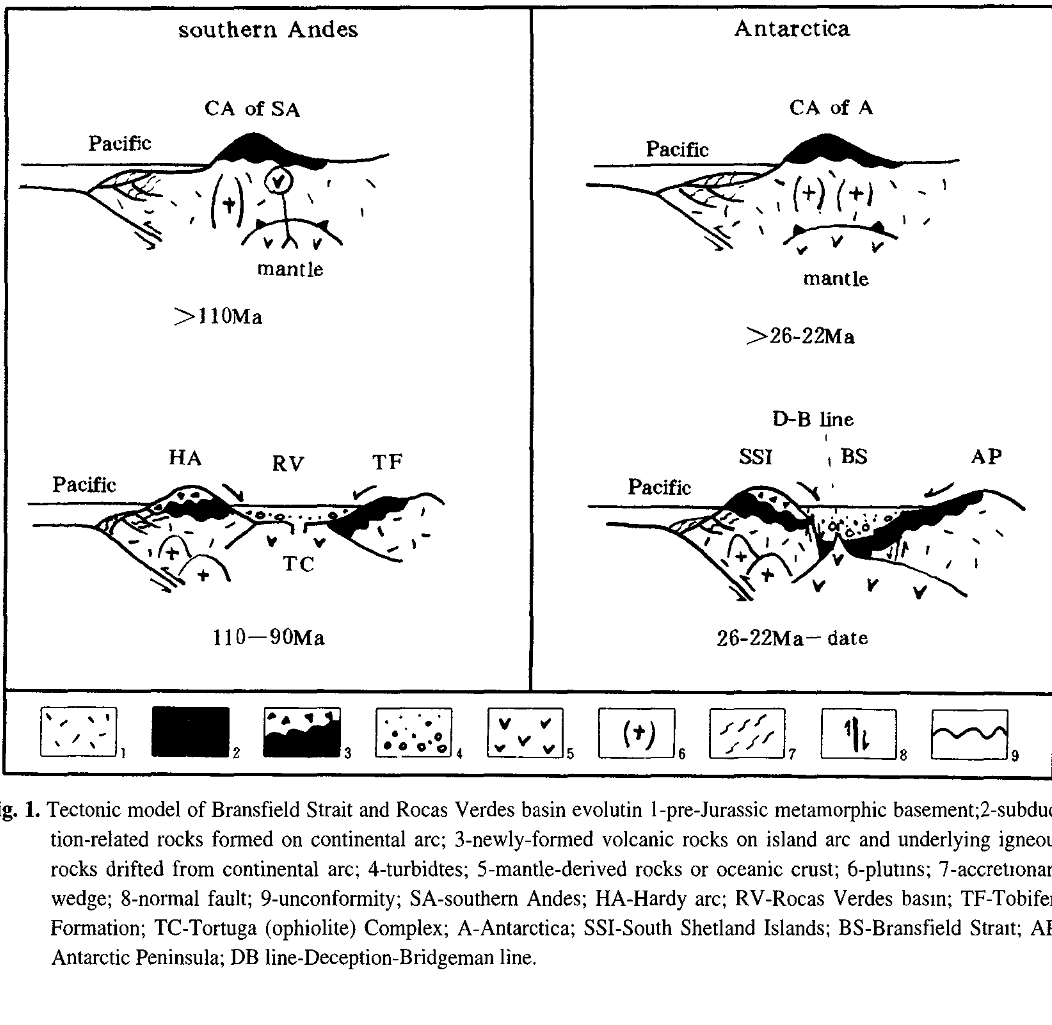

Fig. 1. Tectonic model of Bransfield Strait and Rocas Verdes basin evolutin 1-pre-Jurassic metamorphic basement;2-subduction-related rocks formed on continental arc; 3-newly-formed volcanic rocks on island arc and underlying igneous rocks drifted from continental arc; 4-turbidtes; 5-mantle-derived rocks or oceanic crust; 6-plutins; 7-accretionary wedge; 8-normal fault; 9-unconformity; SA-southern Andes; HA-Hardy arc; RV-Rocas Verdes basin; TF-Tobifera Formation; TC-Tortuga (ophiolite) Complex; A-Antarctica; SSI-South Shetland Islands; BS-Bransfield Strait; AP-Antarctic Peninsula; DB line-Deception-Bridgeman line.

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