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THE GASTRE FAULT SYSTEM: AN INTRA-PLATE BOUNDARY DURING THE INITIAL RIFTING OF GONDWANA ?

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INTRODUCTION

The Gastre Fault System (GFS) is a prominent NW-SE shear zone in the Northpatagonian Massif, with individual faults inferred to occupy a zone at least 30 km wide (Fig. 1) (Coira et al., 1975). It has been recently been shown that the GFS is spatially and genetically related to the Batholith of Central Patagonia, a Late Triassic-Early Jurassic plutonic-volcanic cal-calkaline belt (Rapela et al., 1991).

The GFS constitutes a remarkably significant geological boundary (Rapela & Pankhurst, 1991):

1) It is the southern limit of the Permo-Triassic granite-rhyolite province (see Rapela & Kay, 1988; Kay et al., 1989).

2) The northwesterly projection of the GFS cuts the coast of Chile at 38 S, just south of both the southernmost exposures of late Paleozoic granitoids in the Southern Coastal Batholith (Hervet al., 1987) and the southernmost exposures of the continental Triassic sediments along the Coastal Cordillera. On the other hand, it is the northern limit of the Mesozoic-Cenozoic Patagonian batholith.

3) It appears to mark a significant change in the nature of the Paleozoic basement rocks of the Coastal Cordillera, with the occurrence of rocks

of oceanic provenance (cherts and MORB-type basalts) only to the south of this point (Herve et al., 1981; Herve, 1988).

4) There is also a distinction, in term of age and chemical characteristics between the early Mesozoic rhyolitic suites of extra-Andean Patagonia north and south of the GFS. Those within or to the north are older (; 180-230 Ma) and in some cases have alkalic signatures (eg. Marifil Group, Haller et al., 1990), whereas those to the south (Chon-Aike Formation) are younger (; 155-175 Ma, De Barrio, 1989) and mostly calc-alkaline (Uliana & Biddle, 1987).

There is no evidence of recent seismicity in the GFS, but epicenters along the Chilean coast south of 38 S are displaced westwards relative to those to the north and the concentration of epicenters near its Pacific termination is higher than in neighboring sectors of the Chilean coast (Corvalan, 1981).

The GFS as a geological boundary is interpreted as a crustal discontinuity representing a late Triassic-early Jurassic intraplate boundary associated with the initial rifting and break-up phase of Gondwana (Rapela & Pankhurst, op. cit.). In this paper we examine the correspondence of the GFS with similar structures in the Malvinas/Falkland-Plateau (MFP), as well as the compatibility of this hypothesis with the available paleomagnetic evidence. Geological considerations implicit in the model have been discussed elsewhere (Rapela & Pankhurst, op. cit.).

THE GFS AS THE PATAGONIAN COUNTERPARTS OF THE MARGINAL FRACTURE RIDGE AND AGHULAS-MALVINAS/FALKLAND FRACTURE ZONE

The early Mesozoic history of the dextral GFS is even more remarkable when viewed in the context of the Jurassic reconstruction of Western Gondwana (Fig 1). The prominent Aghulas/Malvinas Fracture Zone (FAFZ), which was active during the early Cretaceous opening of the South Atlantic (Rabinowitz & Labrecque, 1979), appears geometrically continuous with the GFS. Seismic stratigraphical evidence indicate that a precursor of the FAFZ was active at "least during the Middle Jurassic" and probably earlier, as a Marginal Fracture Ridge (MFR) along the north side of the Malvinas/Falkland Plateau (Lorenzo & Mutter, 1988).

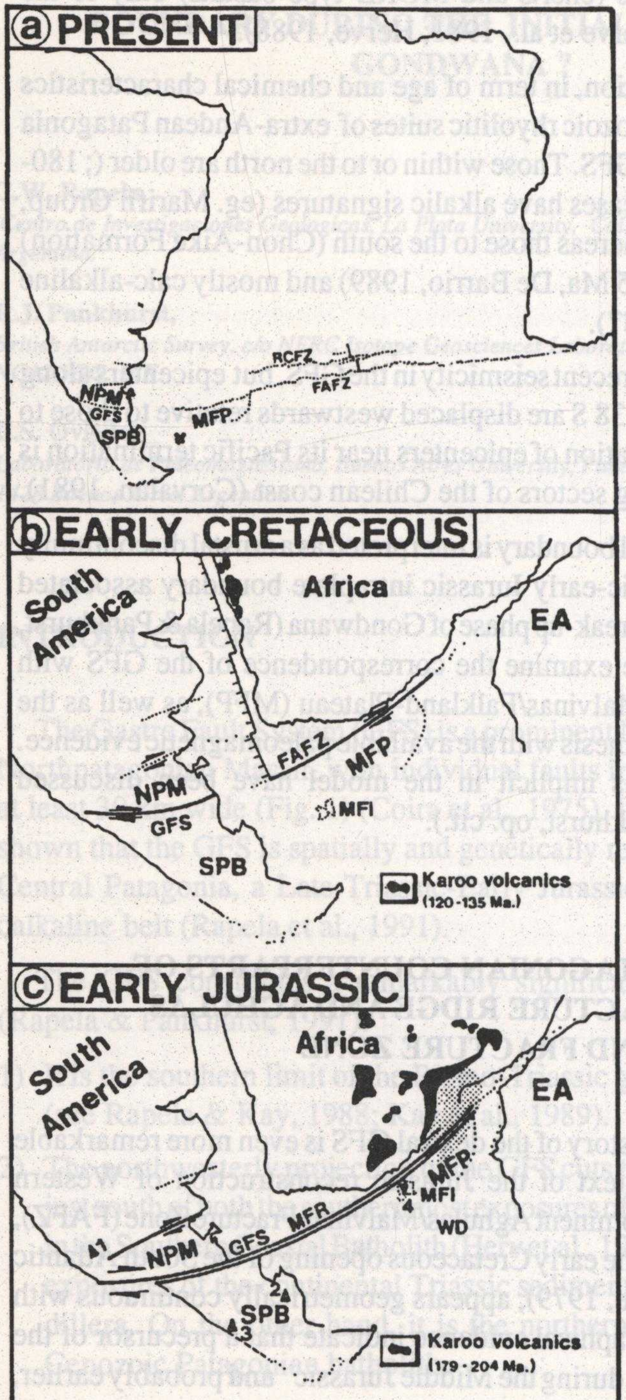

FIGURE 1: Sketches of western Gondwana, illustrating the model suggested in this paper. EA: East Antarctica, FAFZ: Malvinas/Falkland-Aghulas Fracture Zone, GFS: Gastre Fault System, MFR: marginal fracture ridge (Lorenzo & Mutter, 1988), RCFZ: Rio Colorado Fracture Zone, MFI: Malvinas/Falkland Islands, , MFP: Malvinas/Falkland Plateau, NPM: North Patagonian Massif, SPB: Southern Patagonian Block, WD: Weddell Sea. The distribution and ages of Karoo volcanic rocks is from Duncan (1987) and Marsh (1987).
(a): Present day configuration (simplified from Cande et al., 1988).
(b): Configuration after displacement of the SPB , MFP and MFI blocks (pre-drift palaeogeography). Sea-floor spreading associated with the drifting phase of continental separation was simultaneous with the 120-130 Ma basaltic volcanism in southwest Africa.
(c): Early Jurassic palaeogeography prior to dextral displacement. The Late Triassic position of the MFI is based on paleomagnetic data (Taylor & Shaw, 1989). The patterned field is the area of thinned continental lithosphere produced during the early Karoo event (Marsh, 1987). Sites of sampling of paleomagnetic poles; 1: SAP14; 2:SAJ2; 3:SAK15 and 4:MAJ1 (see text).

Calculations using the rotation pole of the first opening movements of the South Atlantic Ocean (lat. 3.2 S and long. 177.4 E, Norton & Sclater, 1979), show that the projection of the FAFZ on the South American continent is coincident with the GFS. Moreover, the other important fracture zone north of the FAFZ (Cande et al., 1988) here called the Rio Colorado Fracture Zone (RCFZ), also seems to have continuity with the dextral fault system of the Colorado river (Japas, 1988).

A new model for the pre-drift configuration of southern South America is proposed assuming the dextral GFS-MFR system was an intraplate boundary between northern Gondwana and the combined Southern Patagonian Block (SPB) and the Malvinas-Falkland Plateau (MFP). The FAFZ rotation pole is used to adjust the pre-drift position of the SPB and MFP blocks south of the GFS. Since dextral movements occurred mainly south of the FAFZ (MFR)-GFS, this has no effect on the fit between South America and Africa. The amount of angular rotation is limited by the fit to the African and East Antarctic blocks. However the MFP is considered to have been lengthened by at least 450 km in east-west direction before the initiation of drift during the lower Cretaceous (Lorenzo & Mutter, op.cit.). Therefore, depending on the extent to which the MFP is considered to be floored by oceanic or stretched-continental crust (Taylor & Shaw, 1989) and the amount of any pre-drift extension, up to 700 km of dextral displacement could be accommodated. In the new model for the pre-drift configuration of southern South America shown in Fig. 1c, we assume about 500 km of dextral displacement of the SPB-MFP blocks as a workinghypothesis. This simplified model considers only dextral displacement along the GFS-MFR system. However, it is highly probable that this dextral displacement was shared among other coeval but less prominent faults of the North Patagonian Massif, such as the Rio Colorado fault noted above.

COMPATIBILITY WITH PALEOMAGNETIC EVIDENCE

Although scarce, the existing paleomagnetic data from Patagonia and the Malvinas/Falkland islands (MFI) appear to be consistent with this type of model (see Fig. 3b for locations). North of the GFS, site SAP14 (Choiyoi Formation, Permian s.l.) has been interpreted as indicating an 80 clockwise rotation caused by dextral transcurrent movements (Rapalini et al., 1989) - in this case along the northern margin of the North Patagonian Massif.

This is consistent with that the North Patagonian Massif could have also undergone dextral movements (Rapalini, 1989) like the SPB. In the MFI, MAJ1 (Lower Jurassic basic dykes) has been interpreted as signifying clockwise rotation and a large displacement (more than 500 km) of the islands between 215 and 122 Ma ago, from an original position east of the Cape Fold Belt (Mitchell et al., 1986; Taylor & Shaw, op. cit.). This pattern of movement can be explained by the transtensional model of Fig. 1c.

The only available Jurassic paleomagnetic pole within the SPB is SAJ1 (Chon-Aike Formation, 166 - 5 Ma, Vilas, 1974), the position of which is consistent with SAJ2 (158 Ma, Maranhao Basin, Brazil, Schult & Guerreiro, 1974) and the African paleomagnetic poles (Oviedo et al., in press) in the conventional reconstruction of Western Gondwana. Finally, SAK15, also from the SPB (Patagonian Plateau Basalts, 62-76 Ma), has been interpreted as consistent with the present configuration of South America (Butler et al., 1991). These comparisons suggest that large-scale dextral displacement along the MFR-GFS system had probably finished by Middle-Upper Jurassic times: together with the association with the acid magmatism of the Central Patagonia Batholith and the Marifil Group noted above, such movements are apparently constrained to the Lower-Middle Jurassic interval.

IMPLICATIONS FOR THE MAGMATISM OF THE KAROO PROVINCE

Eruption of the Etendeka flood basalts of southwestern Africa (120-130 Ma) and the roughly contemporaneous Serra Geral basalts of Brazil have been related to sea-floor spreading (anomaly M10) during the opening of the South Atlantic (White & Mckenzie, 1989). The more voluminous magmatic episodes of the Karoo province in southeastern and south central Africa are older (178-204 Ma) and not obviously related with the drift phase and associated sea floor spreading (Duncan, 1988; Marsch, 1988). Jurassic basalts also occur in the Weddell Sea basin, on the southeastern side of the MFP (White & McKenzie, op. cit.) and the MFI (Cingolani & Varela, 1975) (see Fig. 1c)

The tectonic scenario depicted in Fig. 1c suggest that the 183-207 Ma acid magmatism of northern Patagonia and the coeval early episode of the Karoo Province were related to the major faulting episode represented by the transtensional GFS-MFR system. This rifting event extended the crust and displaced the MFP and the SPB before the initiation of the drift. The Malvinas/Falkland islands block was displaced and rotated during this transtensional episode which initiated the break-up of Gondwana.

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