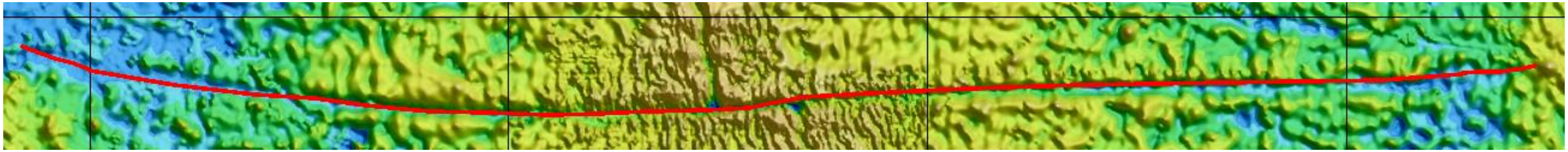
Fast-Track Brazil - May,2019.

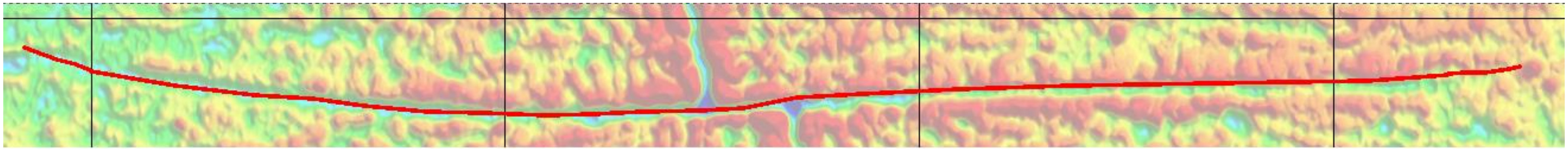
Strakhov Fracture Zone (known as Four North Fracture Zone)

On-line GEBCO Gazetteer

Digital Terrain Model - DTM



Free-Air model



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Tectonic fabric map of the ocean basins from satellite altimetry data

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Abstract

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Satellite altimetry data provide a new source of information on the bathymetry of the ocean floor. The tectonic fabric of the oceans (i.e., the arrangement of fracture zones, ridges, volcanic plateaus and trenches) is revealed by changes in the horizontal gravity gradient as recorded by satellite altimetry measurements. SEASAT and GEOSAT altimetry data have been analyzed and a global map of the horizontal gravity gradient has been produced that can be used to identify a variety of marine tectonic features. The uniformity of the satellite coverage provides greater resolution and continuity than maps based solely on ship-track data. This map is also the first global map to incorporate the results of the GEOSAT mission, and as a result, new tectonic features are revealed at high southerly latitudes.

This map permits the extension of many tectonic features well beyond what was previously known. For instance, various fracture zones, such as the Ascension, Tasman, and Udintsev fracture zones, can be extended much closer to adjacent coninental margins. The tectonic fabric map also reveals many features that have not been previously mapped. These features include extinct ridges, minor fracture zone lineations and seamounts. In several areas, especially across aseismic plateaus or along the margins of the continents, the map displays broad gravity anomalies whose origin may be related to basement structures.

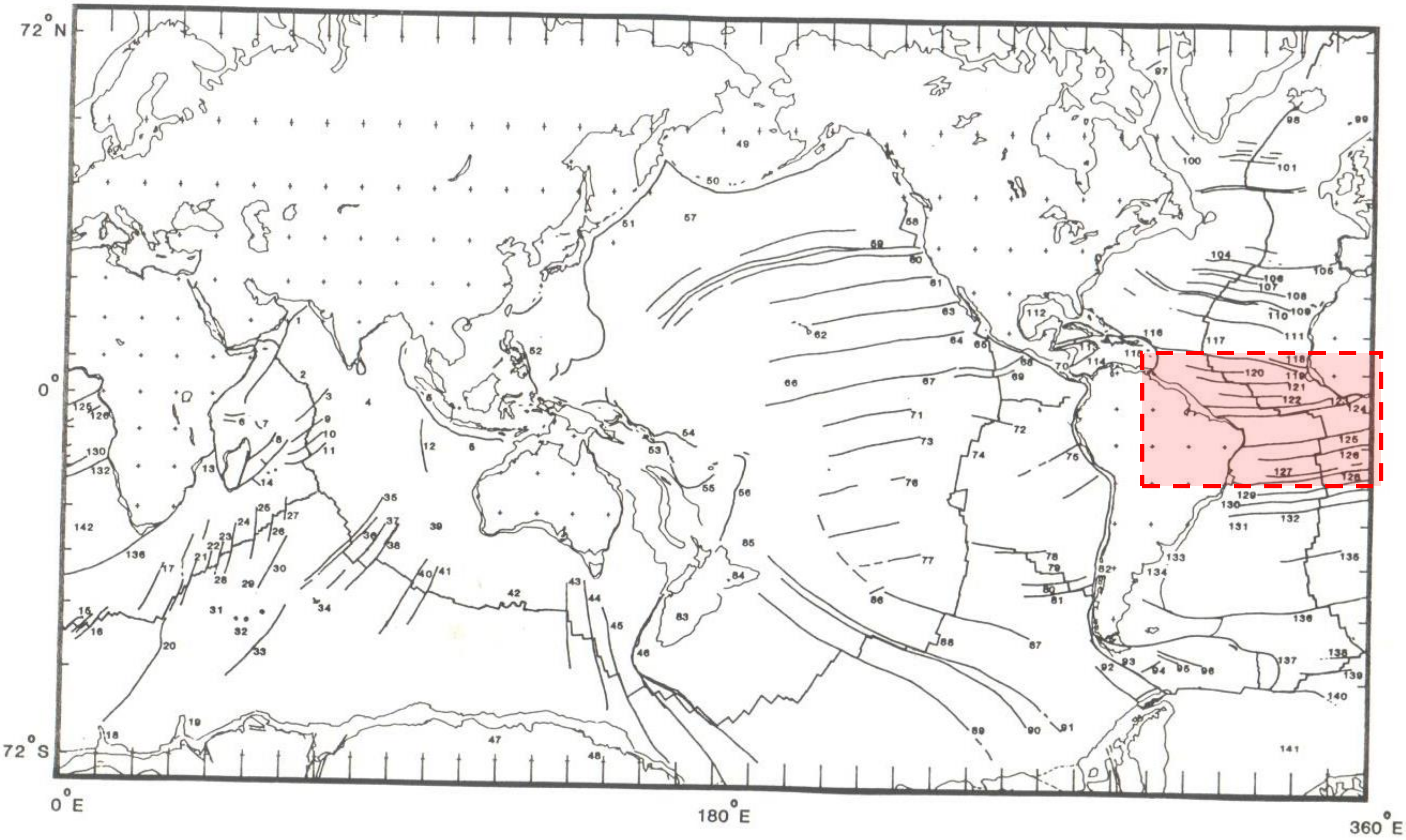
72° N
0°
72° S
0° E
180° E
360° E

Fig. 8. Areas mentioned in the text as well as features that are visible on the tectonic fabric map are shown here.

Indian Ocean: *1*—Owen Fracture Zone (FZ); *2*—Carlsberg Ridge; *3*—Mabahiss FZ; *4*—Central Indian basin; *5*—Java–Sumatra Trench (TR); *6*—Somali Basin; *7*—Amirante TR; *8*—Mahanoro and Mauritius FZ; *9*—Vema FZ; *10*—Argo FZ; *11*—Marie Celeste FZ; *12*—Investigator FZ; *13*—Davie Ridge; *14*—Mascarene Basin; *15*—Bouvet, Moshesh and Isla Orcadas FZ; *16*—Shaka and Dingaan FZ; *17*—Dutoit FZ; *18*—Astrid Ridge; *19*—Gunnerus Ridge; *20*—Astrid FZ; *21*—Prince Edward FZ; *22*—Bain FZ; *23*—Discovery FZ; *24*—Indomed FZ; *25*—Gallieni FZ; *26*—Atlantis II FZ; *27*—Melville FZ; *28*—Del Caño Rise; *29*—Crozet Bank; *30*—L'Astrolabe FZ; *31*—Conrad Rise; *32*—Marie Dufresne Seamount; *33*—Kerguelen FZ; *34*—Kerguelen Plateau; *35*—Amsterdam FZ; *36*—St. Paul FZ; *37*—Mitra FZ; *38*—Varuna Fz; *39*—Broken Ridge Plateau; *40*—Soma FZ; *41*—Surya FZ; *42*—Australian–Antarctic Discordance; *43*—George V FZ; *44*—Tasman FZ; *45*—Balleny FZ; *46*—Macquarie Ridge; *47*—Wilkes Land; *48*—George V Land.

Pacific Ocean: *49*—Bering Sea; *50*—Aleutian TR; *51*—Kuril TR; *52*—Philippine TR; *53*—South Solomon TR; *54*—Vitiaz TR; *55*—New Hebrides TR; *56*—Tonga–Kermadec TR; *57*—Emperor Seamounts; *58*—Juan de Fuca Ridge; *59*—Mendocino FZ; *60*—Pioneer FZ; *61*—Murray FZ; *62*—Hawaiian Islands; *63*—Molokai FZ; *64*—Clarion FZ; *65*—Rivera FZ; *66*—Line Islands; *67*—Clipperton FZ; *68*—Tehuantepec FZ; *69*—Siquieros FZ; *70*—Mid-American TR; *71*—Galapagos FZ; *72*—Quebrado FZ; *73*—Marquesas FZ; *74*—East Pacific Rise; *75*—Mendana FZ; *76*—Austral FZ; *77*—Agassiz FZ; *78*—Chile FZ; *79*—Chile Rise; *80*—Valdivia FZ; Guafo FZ; *82*—Peru–Chile TR; *83*—Cambell Plateau; *84*—Chatham Rise; *85*—Louisville Ridge; *86*—Henry Trough; *87*—Menard FZ; *88*—Pacific–Antarctic Ridge; *89*—Udintsev FZ; *90*—Tharp FZ; *91*—Heezen FZ; *92*—Hero FZ; *93*—Shackleton FZ; *94*—West Scotia Ridge; *95*—Quest FZ; *96*—Endurance FZ.

Atlantic Ocean: *97*—Baffin Bay; *98*—Reykjanes Ridge; *99*—Faeros Ridge; *100*—Labrador Sea; *101*—Bight FZ; *102*—Charlie Gibbs FZ; *103*—Kurchatov FZ; *104*—Pico FZ; *105*—East Azores FZ; *106*—Ocanographer FZ; *107*—Hayes FZ; *108*—Cruiser FZ; *109*—Atlantis FZ; *110*—Tyro FZ; *111*—Kane FZ; *112*—Gulf of Mexico; *113*—Cayman Trough; *114*—Hess Escarpment; *115*—Muertos Trough; *116*—Puerto Rico TR; *117*—Atlantic Ridge; *118*—Jacksonville FZ; *119*—Fifteen-Twenty FZ; *120*—Vema FZ; *121*—Sierra Leone FZ; *122*—Four North FZ; *123*—St. Paul FZ; *124*—Romanche FZ; *125*—Ascension FZ; *126*—Bode Verde FZ; *127*—St. Helene; *128*—Hotspur FZ; *129*—Martin Vaz FZ; *130*—Rio de Janeiro FZ; *131*—Rio Grande Ridge; *132*—Rio Grande FZ; *133*—Salado Basin; *134*—Colorado Basin; *135*—Tristan da Cunha FZ; *136*—Falkland–Agulhas FZ; *137*—South Sandwich TR; *138*—Conrad FZ; *139*—Bullard FZ; *140*—South Sandwich FZ; *141*—Weddell Sea; *142*—Walvis Ridge.

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Deformation of the Oceanic Crust Between the North American and South American Plates

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Fracture zone trends and magnetic anomalies in the Atlantic Ocean indicate that the North American plate must have moved with respect to the South American plate during the opening of the Atlantic. A comparison of plate tectonic flow lines with fracture zones identified from Geosat and Seasat altimeter data suggests that the North American-South American plate boundary migrated northward from the Guinea–Demarara shear margin to the Vema Fracture Zone before chron 34 (84 Ma), to north of the Doldrums Fracture Zone before chron 22 (51.9 Ma), and to north of the Mercurius Fracture Zone between chron 32 (72.5 Ma) and chron 13 (35.5 Ma) . The paleoridge offset through time identified from magnetic anomalies and the computed cumulative strike slip motion in the plate boundary area, indicate that the triple junction may have been located between the Mercurius and the Fifteen-Twenty fracture zones after 67 Ma (chron 30). Plate reconstructions indicate a Late Cretaceous phase of transtension, followed by transpression in the Tertiary for the Tiburon/Barracuda Ridge area south of the Fifteen-Twenty Fracture Zone. The ocean floor in this area is characterized by a series of ridges and troughs with large Bouguer gravity anomalies (up to ~135 mGal). We use smoothing spline estimation to invert Bouguer anomalies for crustal layer structure. Our model results suggest that the Moho is uplifted 2-4 km over short wavelengths (~70 km) at the Barracuda and Tiburon ridges and imply large anelastic strains. The severely thinned crust at the two ridges implies that crustal extension must have taken place before they were uplifted. We propose that the North-South American plate boundary migrated to the latitude of the Tiburon Ridge, bounded by the Vema and Marathon fracture zones, before chron 34 (84 Ma). Post-chron 34 crustal thinning during a transtensional tectonic regime may have been localized at preexisting structural weaknesses such as the Vema, Marathon, Mercurius, and Fifteen-Twenty fracture zone troughs, but reaching the Fifteen-Twenty Fracture Zone and future Barracuda Ridge area only after chron 32 (72.5 Ma). This interpretation concurs with our crustal structural model, which shows stronger crustal thinning underneath the Tiburon Ridge than at the Barracuda Ridge. Subsequent transpression may have continued along the existing zones of weakness in the Tertiary, creating the presently observed crustal deformation and uplift of the Moho, accompanied by anelastic failure of the crust. Middle-Eocene-Upper Oligocene turbidites on the slope of the Tiburon Ridge, now located 800 m above the abyssal plain, suggest that most of its uplift occurred at post-Oligocene times. The unusually shallow Moho underneath the Tiburon and Barracuda ridges represents an unstable density distribution, which may indicate that compressive stresses are still present to maintain these anomalies, and that the North American-South American plate boundary may still be located in this area.

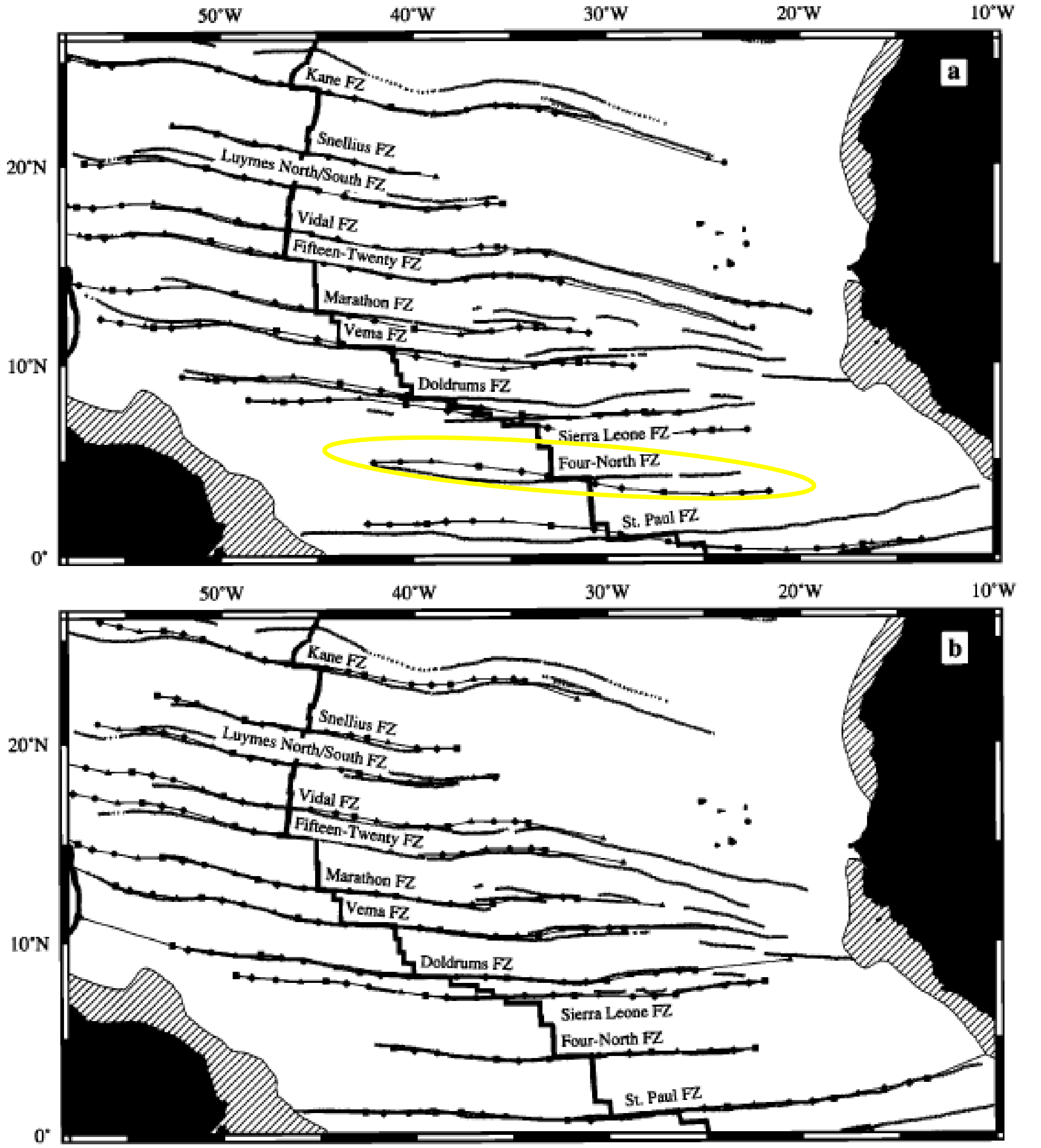

Fig. 3. Fracture zones identified from Geosat and Seasat altimetry data and plate tectonic flow lines from (*a*) North American-African stage poles and (see *Müller and Roest* [1992] for summary) and (*b*) from South American-African stage poles [*Shaw and Cande*, 1990]. Flow lines in Figure 3*a* are constructed for chrons 5 (10.0 Ma), 6 (20.0 Ma), 13 (35.5 Ma), 21 (49.5 Ma), 25 (59.0 Ma), 30 (67.5 Ma), 32 (72.5 Ma), 33y (74.3 Ma), 33o (80.2 Ma), 34 (84.0 Ma), M-0 (118.0 Ma), M-4 (126.0 Ma), M-10N (131.5 Ma), M-16 (141.5 Ma), M-21 (149.5 Ma), and M-25 (156.5 Ma); The South Atlantic flow lines in Figure 3*b* are computed for chrons 5 (8.9 Ma), 6 (19.4 Ma), 8 (26.9 Ma), 13 (35.3 Ma), 20 (44.7 Ma), 22 (51.9 Ma), 25 (58.6 Ma), 30 (66.7 Ma), 33y (74.3 Ma), 33o (80.2 Ma), 34 (84.o Ma) and 100 Ma (extrapolated from the stage 33o-34). See text for discussion. The central North Atlantic flow lines (a) mismatch all fracture zones south of the Sierra Leone Fracture Zone (SLFZ) for times younger than chron 34 (84 Ma) and mismatch all fracture zones south of the Fifteen-Twenty Fracture Zone (Fifteen-Twenty Fracture Zone) for times younger than chron 13 (36 Ma); the South Atlantic flow lines (b) clearly mismatch fracture zones north of the Fifteen-Twenty Fracture Zone. The North American-South American plate boundary must have been located in the area between the Fifteen-Twenty Fracture Zone and the SLFZ through most of the spreading history in this area. Hatchures indicate stretched continental crust.