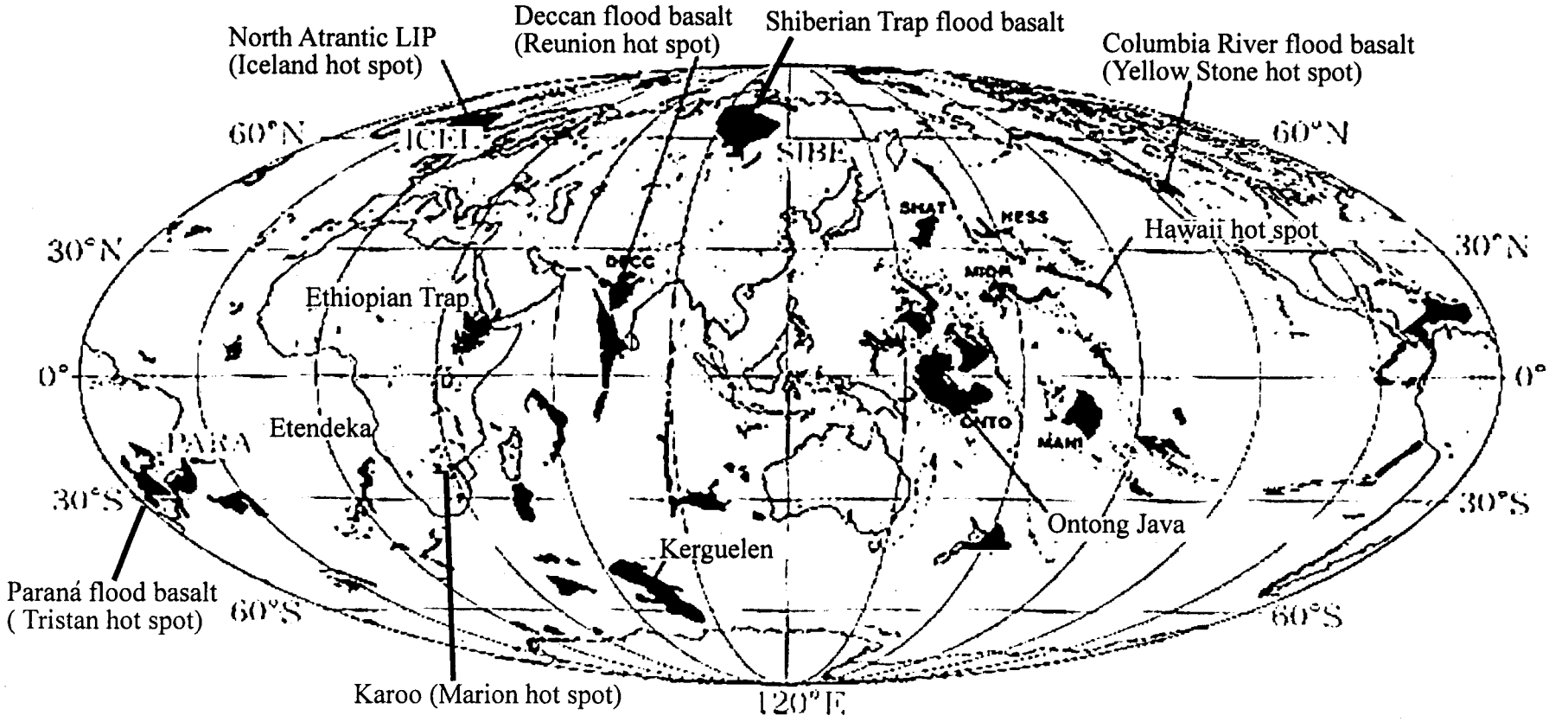

Location of large igneous province (LIP).
(From White, R. and McKenzie, D. (1989); Takahashi, E. and Nakajima, K. (1997); Courtillot, V., Jaupart, C., Manighetti, P. and Besse, T.J. (1999))

Fig. II-1-2-1 Global distribution of the major Large Igneous Province (LIP)

Table II-1-2-2 Major flood basalts and continental breakup (White and McKenzie, 1989)

Ocean Basin	Onset of Seafloor Igneous Province Spreading, Ma (Magnetic Chron)	Igneous Province	Flood Basalts			
			Age Span, (Ma)	(Main Age) Ma	Duration, m.y.	Area (x1000km^2)
North Atlantic	58-56[α] (24r)	British Tert. Ig. Prov.	63-52	(59)	2-3	500
		East Greenland	57-53		~3	54
		West Greenland	62-53	(58-54)	3-4	55
South Atlantic	130-117 (M9-M4)[j]	Parana	130-120	(~ 120)	'1 to a few'	1200
		Etendeka	128-113	(~ 120)	2	15
Indian Ocean-Seychelles	64 (27r)[α]	Deccan	67-60	(66)	~0.53	>1000
Red Sea-Gulf of Aden		Ethiopian Flood basalts	30-15	(~ 25)	"most intense at earlier time"	750
		Aden and Yemen traps	29-20	(~ 27)		
Gondwana Breakup		Karoo	200-175	(193)	a few m.y.'	> 150
		Antarctic	179-162			
---		Columbia River	17-6	(17-13.5)	<3.5 m.y.	200

Almost all the flood basalt has a hotspot that is concerned with its formation. For example, the Tristan hotspot relates to the Paraná flood basalt, the Yellowstone hotspot relates to the Columbia River flood basalt and so on. The eruption of flood basalt is considered to be the igneous activity of the early stage that accompanied a specific hotspot.

The example of the Paraná flood basalt is shown in Fig. II-1-2-2. The activity of the Paraná flood basalt began at the period of the expansion of the South Atlantic Ocean that forced the separation of South America and Africa (approximate 130 Ma, Fig. II-1-2-2(a)). At present, the Tristan hotspot (Mid-Atlantic ridge) is located in the Atlantic, midway in the Paraná flood basalt and the Etendeka flood basalt associated with forming the flood basalt (Fig. II-1-2-2(b)).

In Large Igneous Province, there are igneous rock bodies of the marginal part of continents besides flood basalt plateau, plateau, ridge and the line of seamounts. The igneous rock bodies of the marginal part of continents are markedly distributed in the marginal part of the continent in the North Atlantic Ocean. They are the large volume of igneous rock bodies that erupted just after the separation of continents. The igneous rock body was formed by the large volume of the eruption when the lithosphere became markedly thin. Compared to Deccan type mantle plume, the large volume of melt was generated by the ascending of the high temperature mantle to shallower part. For example, in the case of the igneous rock body offshore of Greenland, it was formed at 60 Ma of the separation of the continent, the activity still continues to make Iceland hotspot. In the case of the basalt plateau of the marginal part of the continent, almost all the part finally subducts into the mantle as the plateau.

(2) Occurrence and Petrological Characteristics

The panoramic view photo of the Deccan flood basalt is shown in Fig. II-1-2-3. Since the Deccan flood basalt has not been affected by marked structural movement and is rarely covered by vegetation, the occurrence is well observed. As shown in the distant view photo, the piling of the lava flows looks like sedimentary rock. The characteristic occurrence is described below.

- Low viscosity: In the case of the Deccan flood basalt, one lava flow reached 200 kilometers.
- No clinker
- Less phenocryst

Since the density of basalt magma is higher than that of granitic rocks, that is the main rock component of the crust. It cannot pass through the crust easily and spreads horizontally forming dykes or sills. Therefore, dykes and sills of large scale develop in the distribution area of flood basalt.

Flood basalt is mainly composed of tholeiitic basalt that is accompanied by a small volume

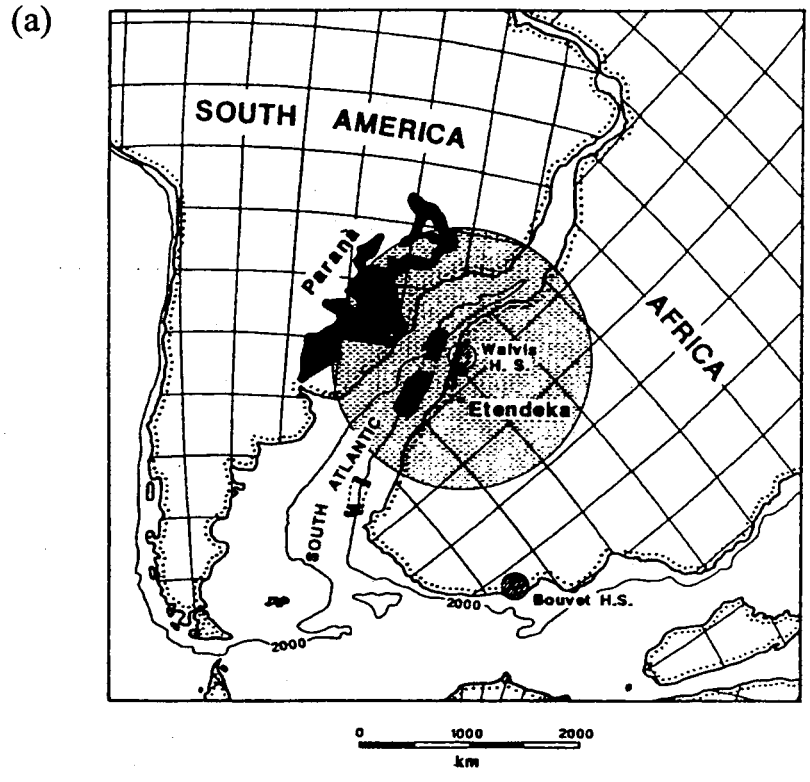

Fig. 15. Reconstruction of South Atlantic at anomaly M4 time (approximately 120 Ma) shortly after the onset of seafloor spreading. Solid shading shows areas of extrusive basalts. Extent of Paraná basalts from *Hawkesworth et al.* [1986], Etendeka basalts from *Eales et al.* [1984], offshore areas from seaward dipping reflectors reported by *Hinz* [1981], *Gerrard and Smith*, [1982] and *Austin and Uchupi* [1982]. Shaded area around Walvis hot spot shows extent of mushroom head of abnormally hot mantle. Equal area projection is centered on the hot-spot location.

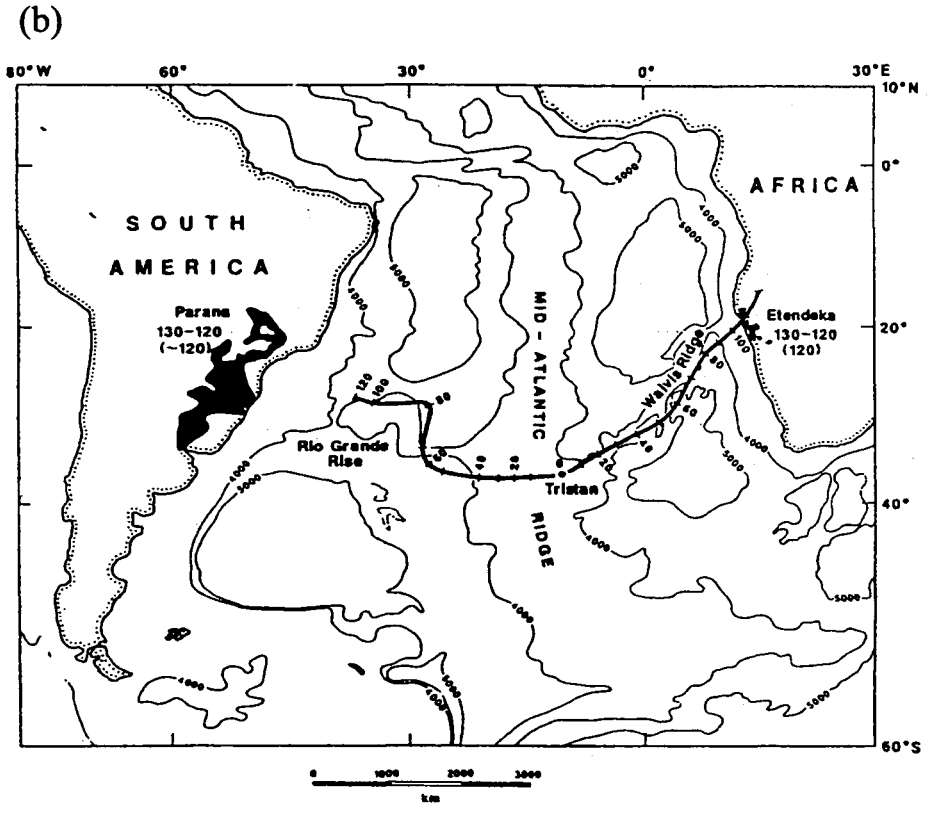

Fig. 16. Present configuration of the South Atlantic showing the thick volcanic ridges of the Rio Grande Rise and the Walvis Ridge produced above the mantle plume as the ocean opened. Hot-spot track is from *Duncan* [1984].

Fig. II-1-2-2 Relationship of the continental breakup and the flood basalts

The flood basalt occasionally accompanies the continental breakup. As the example, Parana and Etendeka (White and McKenzie , 1989).

Fig. II-1-2-3 Panoramic view of the lava flow in the Deccan Trap (Takahashi and Nakajima, 1997, The photographer: T. Fujii)

The lava flow of Deccan trap is horizontally piled, and it is seen the sedimentary rock in the distant view.