by K. Tamaki and E. Honza

Global tectonics and formation of marginal basins: Role of the western Pacific

The western Pacific has produced more than 75 percent of the marginal basins found on the Earth today. The formation of marginal basins has been left unsolved outside the elegant framework of plate tectonics. The solution of the problem should be hidden in the great assortment of marginal basins in the western Pacific and in their evolutionary history.

Figure 1.—Marginal basins around the Pacific Ocean. Solid areas show marginal basins, and blocked lines show trenches. Abbreviations: E., East; N., North; S., South; W., West.

Introduction

The origin of the marginal basins in the active continental margin has been investigated and discussed since the concept of the backarc basin was first introduced by Karig (1971), Pacham and Falvey (1971), and Sleep and Toksöz (1971). The origin of basin formation, however, has remained an unsolved problem for a long time (Taylor and Karner, 1983), whereas the theory of plate tectonics has solved magnificently an enormous number of problems in geology and geophysics in the short period since the inception of the theory.

As illustrated in figure 1, the continental margin of the western Pacific Ocean is the region where more than 75 percent of the marginal basins in the world are concentrated. The western Pacific currently forms the world's largest subduction zone and may readily be called the western Pacific supersubduction zone. It surrounds the

Figure 2.—Estimated subduction around the Pangea supercontinent at 180 Ma. Heavy sawtoothed line, subduction zone; dashed line, spreading axis.

margin of the older rim of the Pacific plate from the Aleutian Trench in the northern Pacific to the Puysegur Trench south of New Zealand in the southern Pacific. If we take into account the high subduction rates and the enormous length of the subduction zone, it is unequivocal that the western Pacific supersubduction zone is playing a major role in the consumption into the deep mantle of the oceanic lithosphere of the Earth. Furthermore, the western Pacific supersubduction zone has had this major role not only in the present but also since 180 Ma, at least, throughout the Earth's whole history since the breakup of the Pangea supercontinent (fig. 2). The concentrated distribution of the marginal basins in the western Pacific probably has an intimate relationship with the activity of the supersubduction zone. Here, on the occasion of the 29th. International Geological Congress (IGC) held in the western Pacific, we summarize the characteristics of the marginal basins and discuss the formation of the marginal basins.

Marginal basins and subduction zones

Although the marginal basins of the world show a variety of geographical features, only two groups of marginal basins exist: subduction-related marginal basins and nonsubduction-related marginal basins. Subduction-related marginal basins are divided further into two groups according to their origin. The most pronounced basin is the backarc basin that is formed on the backarc side of an active arc by the sea-floor spreading process that follows the rifting of the arc. The currently active Mariana Trough and Lau Basin clearly reside in this group. The other group of subduction-related marginal basins are those that are formed by entrapment of part of a major ocean basin due to the emergence of a new subduction zone in the ocean basin. The Aleutian and Caribbean Basins are typical of this group (Scholl and others, 1986; Duncan and Hargraves, 1984). The Banda Basin also may be a trapped Mesozoic Indian Ocean plate (Lapouille and others, 1985; Lee and McCabe, 1986). The Tasman Basin, whose spreading center was a part of the major spreading center between the Pacific and Antarctica plates, was trapped behind New Zealand when

the Pacific-Antarctica spreading center was connected to the Australia-Antarctica spreading center.

Today, a few cases of nonsubduction-related marginal basins are found. The most prominent case is the Cayman Trough in the Caribbean Sea. It has been active since 40 Ma as a pull-apart basin between the North America and Caribbean plates (Rosencrantz and others, 1988).

The Caroline Basin, located on the seaward side of the trench system in the equatorial western Pacific, appears to be a nonsubduction-related marginal basin. The Caroline Basin, however, may have had an origin similar to that of the currently active North Fiji Basin as a backarc basin, and it may have been welded to the Pacific plate to travel westward to its current position. The South China, Sulu, Celebes, Coral Sea, and New Caledonia Basins also do not appear to be related to subduction, but they are independent of backarc spreading according to their present configurations apart from trenches. However, most basins are reconstructed as being next to subduction zones in earlier times and are thought to be remnants of backarc basins that were formed by the retreat of the trenches from the basins (Honza, 1991).

Thus, most marginal basins have origins related to subduction. The interaction of major plates associated with subduction causes marginal basins either by in-place spreading (backarc spreading) along the boundary or by entrapment of an old oceanic lithosphere behind the subduction zone. Whereas slower retreat of subduction zones causes backarc spreading, sudden retreat causes a trapped marginal basin. In terms of the interaction between two plates, the sudden jump of a subduction zone that thereby causes entrapment of old lithosphere is an extreme case of the interaction, and it may not be significantly different from the gradual retreat of a trench that causes backarc spreading.

Characteristics of marginal basins

Marginal basins have several characteristics distinguishing them from the major ocean basins of the Pacific, Atlantic, and Indian Oceans. All these characteristics are related intimately to the forma-

Figure 3.—Range chart of backarc basin formation. Solid lines show confirmed age ranges of the formation of marginal basins by sea-floor spreading, and broken lines show rough estimates of the age range. Rhombic marks show the timing of entrapment of the basins. Concerned references are as follows. Aleutian, Scholl and others (1986); Andaman, Lawver and Curry (1981); Banda, Lapouille and others (1985); Caribbean, Duncan and Hargraves (1984); Caroline, Weissel and Anderson (1978); Cayman, Rosencrantz and others (1988); Celebes, Weissel (1980), Rangin and others (1990); Central Scotia, Hill and Barker (1980); Coral, Weissel and Watts (1979); East Scotia, Barker (1972); Emerald, Weissel and others (1977); Japan, Tamaki (1986), Tamaki and others (1990); Komandorsky, Langseth and others (1980); Kuril, Kimura and

Tamaki (1986); Lau-Havre, Weissel (1977); Loyalty, Weissel, Watts, and Lapouille (1982); Makassar, Hamilton (1979); Manus, Taylor (1979); Mariana, Hussong and Uyeda (1982); Molucca, Honza (1991); New Caledonia, Burns and Andrews (1973); North Fiji, Malahoff, Hammond, and others (1982); Okinawa, Sibuet and others (1987); Parece Vela, Mrozowski and Hayes (1979); Shikoku, Chamot-Rooke and others (1987); Solomon, Joshima and others (1987); South China, Taylor and Hayes (1980); South Fiji, Malahoff, Feden, and Flemming (1982); Sulu, Rangin and others (1990); Tasman, Weissel and others (1977); West Philippine, Hilde and Lee (1984); Woodlark, Weissel, Taylor, and Karner (1982). Abbreviations: W., West; Q, Quaternary; PLI, Pliocene.

tion of marginal basins and provide the keys to solving the formation of marginal basins. Each of these characteristics should be addressed clearly when the origin of a marginal basin is considered. The characteristics of marginal basins are summarized as follows:

- (1) The distribution of marginal basins shows outstanding characteristics. Most marginal basins are concentrated in the western Pacific region, and the rest of the marginal basins are distributed in the western Atlantic. Noteworthy is the fact that almost all the clusters of marginal basins are distributed at the east side of the major continents. In spite of vigorous subduction at the Peru-Chile Trench, no marginal basins are observed there west of the continent of South America.
- (2) The lives of marginal basins are quite short as compared with those of major oceans, and the formation of marginal basins is intermittent within an area (fig. 3). Usually the life of a marginal basin spreading system is less than 25 m.y. An exception to this is the Cayman Trough in the Caribbean Sea, a nonsubduction-related marginal basin that has been active for the last 45 m.y. The intermittent nature of marginal basin formation is obviously an essential trait and should be critically related to the origin of marginal basins.
- (3) Some marginal basins are going to be destroyed after cessation of spreading. The Sea of Japan is now initiating subduction on the western side of the Japanese islands (Tamaki and Honza, 1985), and this situation may close the basin again. The marginal basins of the Philippine Sea and the South China, Solomon, and Loyalty Basins are apparently subducting along the Nankai-Ryukyu-Philippine, Manila, Solomon, and Vanuatu Trenches, respectively. The Molucca Basin of Southeast Asia is almost vanishing by paired subduction at its eastern and western margins (Hamilton, 1979). These features suggest that marginal basins, once opened by extensional sea-floor spreading tectonism, quite often close by the subduction of the basins themselves.
- (4) Regardless of the supposed 180-m.y.-long activity of the western Pacific supersubduction zone, the marginal basins left in today's ocean are younger than 80 Ma (fig. 3). Older marginal basins may have collapsed, but events of collapse are difficult to detect, and the possibility of the existence of marginal basins older than 80 Ma cannot be addressed fully.
- (5) Some marginal basins apparently have deeper lithospheric depths than the major oceans (Kobayashi, 1984; Park and others, 1990). The Philippine Sea marginal basins, the Japan and Kuril Basins, and the South China, Sulu, Celebes, and Woodlark Basins show water depths that are 600 to 800 m deeper to the basin basement as compared to those of the Pacific, Atlantic, and Indian Ocean basins (fig. 4). Most of these basins are in the northwestern Pacific, which suggests that some regional assimilation may be taking place.
- (6) Marginal basins sometimes change the trend of spreading axes, as observed in the West Philippine and North Fiji Basins (Hilde and Lee, 1984; Auzende and others, 1988). This characteristic may suggest that marginal basins are affected easily by the surrounding tectonic setting and that the associated sea-floor spreading occurs passively rather than actively.

Figure 4.—Age and depth correlations for marginal basins of the world modified from Park and others (1990) and Park (1990). Age-depth correlation curves of a major ocean and the Philippine Sea are shown as references. The Philippine Sea marginal basins (Mariana, Shikoku-Palee Vela, and West Philippine Basins) were identified as the most typical cases of deep marginal basins by Park and others (1990). Most other marginal basins have depths close to those of the major oceans. The curves are represented by $\text{depth} = 2,500 + 350\sqrt{\text{age}}$ for a major ocean (Parsons and Sclater, 1977) and by $\text{depth} = 3,222 + 366\sqrt{\text{age}}$ for the Philippine Sea (Park and others, 1990).

(Karig, 1971) or by secondary convection that is induced by the downgoing slab (Sleep and Toksöz, 1971). Model 2 postulates the injection of a so-called mantle plume that may be related to a hot spot or a hot region (Miyashiro, 1986) or to a counterupwelling against the deep slab penetration.

Models 3 to 5 may be classified as passive opening types when we solely take into account the kinematics of plates on the Earth's surface. Model 3 is a simple kinematic model of powerful retreat of the overriding plate from the subduction zone, which inevitably causes the spreading of a marginal basin (Dewey, 1980). The Manus Basin is the most typical case of this type. As the Pacific plate moves northwestward with a speed of 10 cm/yr, the Manus Basin is spreading by this same amount (Taylor, 1979).

Models 4 and 5 assume retreat of the trench toward the ocean instead of the retreat of the overriding plate toward the land (Carlson and Meria, 1984), as in the previous model. Models 4 and 5 both depend on dynamic asthenospheric flow beneath the subduction zone, and in this regard, they may not be called passive models. Model 4 assumes that constant eastward asthenospheric flow, probably caused by the Earth's rotation as suggested by Uyeda and Kanamori (1979), invokes trench retreat and introduces backarc spreading. This model may well explain the uneven distribution of the marginal basins on the eastern side of the continents. Model 5 assumes ubiquitous fluctuation of the downgoing asthenospheric flow. The downgoing flow takes a part of the globally descending flow of the asthenosphere (Glatzmaier and others, 1990), and it is assumed that the horizontal location of the downgoing flow fluctuates to some extent. The fluctuation causes the repetition of the formation and collapse of marginal basins.

The above five models have to be reviewed by referring to the characteristics of the marginal basins that were summarized in the previous section. Specifically, intermittent spreading and occasional

Models of backarc basin formation

The mechanism of backarc basin formation has long been an enigma. Figure 5 summarizes the previously proposed models and the currently plausible models of backarc spreading. Models 1 and 2 are so-called active opening models. Model 1 supposes some kind of upwelling that is caused by the penetration of a slab beneath the arc. The upwelling may be caused by heat generation along the slab

MODELS OF BACKARC SPREADING

Model 1. Slab-induced upwelling model

Model 2. Plume injection model

Model 3. Plate kinematic model

- retreat of backarc plate

Model 4. Asthenospheric flow model 1

- trench roll back by eastward asthenospheric current

Model 5. Asthenospheric flow model 2

- trench roll back by instability of downgoing asthenospheric flow

Figure 5.—Models of backarc spreading. See text for discussion.

collapse of basins, caused by the alternation of extensional and compressional tectonism, may be consistent with model 5, and the uneven distribution of the marginal basins may be explained well by model 4. A hybrid combination of models 4 and 5 may be a suitable candidate for future study. Model 3 has the unequivocally supporting example of the Manus Basin, so this model actually works in some cases. Probably model 3 has been the case along the plate boundary between the Pacific and Australia plates throughout their interactive history. When the rapidly moving Pacific plate occupies the overriding plate, marginal basins are formed easily between the two plates. The Caroline, North Fiji, Manus, Solomon, Loyalty, and other small basins along this plate boundary may have formed as actual cases of model 3.

Conclusions

As discussed above, we still have several possible models for the formation of marginal basins, that cannot be explained by plate tectonics alone. Does this mean that the solution to their origin is beyond the framework of plate tectonics, that their origin is controlled more strongly by a deep asthenospheric flow mechanism? Because some basins are explained clearly by a kinematic model of plate movements, there may not be a single mechanism for the formation of marginal basins. However, the most significant part of the formation of marginal basins is the fact that marginal basins are formed at an active plate boundary where one plate subducts beneath

another plate. The slab subduction causes arc volcanism on the overriding plate, and the lithosphere there becomes heated and weakened (Honza, 1983). This situation presents the maximum opportunity for marginal basin formation because even a rather weak force, as compared to the major continental rifts, can introduce rifting of the heated lithosphere and further develop marginal basins by sea-floor spreading. Probably this condition is the most fundamental characteristic for the formation of marginal basins, and the basins are formed either by superficial plate kinematics or by an interaction between asthenospheric flow and the subducting slab.

In the coming 29th IGC, we have several symposiums related to the formation of marginal basins. Among them are "Symposium A1: Evolution of Island Arcs and Active Continental Margins" convened by A.J. Barber, X. Le Pichon, and Y. Tatsumi; "Symposium I-3-23: Tectonic Evolution of the Western Pacific and Asian Continent" convened by T. Hilde, G. Kimura, S. Lallemond, and K. Tamaki; and "Symposium I-3-25: Continental and Backarc Rifting—Mechanism, Extension Structures, and Implications for Plate Dynamics" convened by P. Morgan, T. Seno, R.S. White, and A. Yamaji. Additional symposiums have titles of subduction, arc volcanism, and internal Earth deep structures. These topics are all related closely to the formation of marginal basins. We believe that the 29th IGC at Kyoto will present an indispensable opportunity for stimulating the geodynamics of marginal basin formation and that the understanding of the formation of marginal basins will be improved dramatically at this meeting.

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References

- Auzende, J., Lafoy, Y., and Marsset, B., 1988, Recent geodynamic evolution of the north Fiji basin (southwest Pacific): *Geology*, v. 16, p. 925–929.
- Barker, P.F., 1972, A spreading center in the east Scotia Sea: *Earth and Planetary Science Letters*, v. 15, p. 123–132.
- Burns, R.E., and Andrews, J.E., 1973, Regional aspects of deep sea drilling in the southwest Pacific, in Burns, R.E., Andrews, J.E., and others, eds., *Initial reports of the Deep Sea Drilling Project*, v. 21: Washington, D.C., U.S. Government Printing Office, p. 897–906.
- Carlson, R.L., and Melia, P.J., 1984, Subduction hinge migration: *Tectonophysics*, v. 102, p. 399–411.
- Chamot-Rooke, N., Renard, V., and Le Pichon, X., 1987, Magnetic anomalies in the Shikoku basin: A new interpretation: *Earth and Planetary Science Letters*, v. 83, p. 214–228.
- Dewey, J.F., 1980, Episodicity, sequence, and style at convergent plate boundaries, in Strangway, D.W., ed., *The continental crust and its mineral deposits: Geological Association of Canada Special Paper 20*, p. 553–573.
- Duncan, R.A., and Hargraves, R.B., 1984, Plate tectonic evolution of the Caribbean region in the mantle reference frame, in Bonini, W.E., Hargraves, R.B., and Shagam, R., *The Caribbean-South American plate boundary and regional tectonics: Geological Society of America Memoir 162*, p. 81–93.
- Glatzmaier, G.A., Schubert, G., and Bercovici, D., 1990, Chaotic, subduction-like downflows in a spherical model of convection in the Earth's mantle: *Nature*, v. 347, p. 274–277.
- Hamilton, W., 1979, *Tectonics of the Indonesian region: U.S. Geological Survey Professional Paper 1078*, 345 p.
- Hilde, T.W.C., and Lee, C.-S., 1984, Origin and evolution of the West Philippine Basin: A new interpretation: *Tectonophysics*, v. 102, p. 85–104.
- Hill, I.A., and Baker, P.F., 1980, Evidence for Miocene back-arc spreading in the central Scotia Sea: *Geophysical Journal of the Royal Astronomical Society*, v. 63, p. 427–440.
- Honza, E., 1983, Evolution of arc volcanism related to marginal sea spreading and subduction at trench, in Shimozuru, D., and Yokoyama, I., eds., *Arc volcanism and tectonics: Tokyo, Terra Scientific Publishing Company*, p. 177–189.
- Honza, E., 1991, The Tertiary arc chain in the western Pacific: *Tectonophysics*, v. 187, p. 285–303.
- Hussong, D.M., and Uyeda, S., 1982, Tectonic process and the history of the Mariana Arc: A synthesis of the results of Deep Sea Drilling Project Leg 60, in Hussong, D.M., Uyeda, S., and others, eds., *Initial reports of the Deep Sea Drilling Project*, v. 60: Washington, D.C., U.S. Government Printing Office, p. 909–929.
- Joshima, M., Okuda, Y., Murakami, F., Kishimoto, K., and Honza, E., 1987, Age of the Solomon Sea Basin from magnetic anomaly lineations: *Geo-Marine Letters*, v. 6, p. 229–234.
- Karig, D.E., 1971, Origin and development of marginal basins in the western Pacific: *Journal of Geophysical Research*, v. 84, p. 6796–6802.
- Kimura, G., and Tamaki, K., 1986, Collision, rotation, and back-arc spreading: The case of the Okhotsk and Japan Seas: *Tectonics*, v. 5, p. 389–401.
- Kobayashi, K., 1984, Subsidence of the Shikoku back-arc basin: *Tectonophysics*, v. 102, p. 105–117.
- Langseth, M.G., Hobart, M.A., and Horai, K., 1980, Heat flow in the Bering Sea: *Journal of Geophysical Research*, v. 85, p. 3740–3750.
- Lapouille, A., Haryono, H., Larue, M., Pramumijoyo, S., and Lardy, M., 1985, Age and origin of the sea floor of the Banda Sea: *Oceanologica Acta*, v. 8, p. 379–389.
- Lawver, L.A., and Curray, J.R., 1981, Evolution of the Andaman Sea: *EOS (American Geophysical Union Transactions)*, v. 62, p. 1044.
- Lee, C.-S., and McCabe, R., 1986, The Banda-Celebes-Sulu basin: A trapped piece of Cretaceous-Eocene oceanic crust?: *Nature*, v. 322, p. 51–54.
- Malahoff, A., Feden, R.H., and Fleming, H.S., 1982, Magnetic anomalies and tectonic fabric of marginal basins north of New Zealand: *Journal of Geophysical Research*, v. 87, p. 4109–4125.
- Malahoff, A., Hammond, S.R., Naughton, J.J., Keeling, D.L., and Richmond, R.N., 1982, Geophysical evidence for post-Miocene rotation of the island of Viti Levu, Fiji, and its relationship to the tectonic development of the North Fiji Basin: *Earth and Planetary Science Letters*, v. 57, p. 398–414.
- Miyashiro, A., 1986, Hot regions and the origin of marginal basins in the western Pacific: *Tectonophysics*, v. 122, p. 195–216.
- Mrozowski, C.L., and Hayes, D.E., 1979, The evolution of the Parece Vela Basin, eastern Philippine Sea: *Earth and Planetary Science Letters*, v. 46, p. 49–67.
- Pacham, G.H., and Falvey, D.A., 1971, An hypothesis for the formation of marginal seas in the western Pacific: *Tectonophysics*, v. 11, p. 79–109.
- Park, C.-H., 1990, Age-depth correlation of marginal basins in the world and its tectonic implications: Tokyo, University of Tokyo, doctoral thesis, 147 p.
- Park, C.-H., Tamaki, K., and Kobayashi, K., 1990, Age-depth correlation of the Philippine Sea back-arc basins and other marginal basins in the world: *Tectonophysics*, v. 181, p. 351–371.
- Parsons, B., and Sclater, J.G., 1977, An analysis of the variation of ocean floor bathymetry and heat flow with age: *Journal of Geophysical Research*, v. 82, p. 803–827.
- Rangin, C., Silver, E.A., and others, 1990, *Proceedings of the Ocean Drilling Program, initial reports*, v. 124: College Station, Texas, Texas A&M University, 916 p.
- Rosencrantz, E., Ross, M.I., and Sclater, J.G., 1988, Age and spreading history of the Cayman Trough as determined from depth, heat flow, and magnetic anomalies: *Journal of Geophysical Research*, v. 93, p. 2141–2157.
- Scholl, D.W., Vallier, T.L., and Stevenson, A.J., 1986, Terrane accretion, production, and continental growth: A perspective based on the origin and tectonic fate of the Aleutian-Bering Sea region: *Geology*, v. 14, p. 43–47.

- Sibuet, J., Letouzey, J., Barbier, F., Charvet, J., Foucher, J., Hilde, T.W.C., Kimura, M., Ling-Yun, C., Marsset, B., Muller, C., and Stephan, J., 1987, Back arc extension in the Okinawa Trough: *Journal of Geophysical Research*, v. 92, p. 14041–14063.
- Sleep, N.H., and Toksöz, M.N., 1971, Evolution of marginal basins: *Nature*, v. 33, p. 548–550.
- Tamaki, K., 1986, Age estimation of the Japan Sea on the basis of stratigraphy, basement depth, and heat flow data: *Journal of Geomagnetism and Geoelectricity*, v. 38, p. 427–446.
- Tamaki, K., and Honza, E., 1985, Incipient subduction and obduction along the eastern margin of the Japan Sea: *Tectonophysics*, v. 119, p. 381–406.
- Tamaki, K., Pisciotto, K., and others, 1990, Proceedings of the Ocean Drilling Program, initial reports, v. 127: College Station, Texas, Texas A&M University, 844 p.
- Taylor, B., 1979, Bismarck Sea: Evolution of a back-arc basin: *Geology*, v. 7, p. 171–174.
- Taylor, B., and Hayes, D.E., 1980, The tectonic evolution of the South China Basin, in Hayes, D.E., ed., *The tectonics and geologic evolution of Southeast Asian seas and islands*: American Geophysical Union Geophysical Monograph 23, p. 89–104.
- Taylor, B., and Karner, G.D., 1983, On the evolution of marginal basins: *Review of Geophysics and Space Physics*, v. 21, p. 1727–1741.
- Uyeda, S., and Kanamori, H., 1979, Back-arc opening and the mode of subduction: *Journal of Geophysical Research*, v. 84, p. 1049–1062.
- Weissel, J.K., 1977, Evolution of the Lau Basin by the growth of small plates, in Talwani, M., and Pitman, W.C., III, eds., *Island arcs, deep sea trenches and back-arc basins*: American Geophysical Union, Maurice Ewing Series, no. 1, p. 429–436.
- , 1980, Evidence for Eocene oceanic crust in the Celebes Basin, in Hayes, D.E., ed., *The tectonic and geologic evolution of Southeast Asian seas and islands*: American Geophysical Union Geophysical Monograph 23, p. 37–47.
- Weissel, J.K., and Anderson, R.N., 1978, Is there a Caroline plate?: *Earth and Planetary Science Letters*, v. 41, p. 143–158.
- Weissel, J.K., Hayes, D.E., and Herron, E.M., 1977, Plate tectonics synthesis: The displacements between Australia, New Zealand, and Antarctica since the Late Cretaceous: *Marine Geology*, v. 25, p. 231–277.
- Weissel, J.K., Taylor, B., and Karner, G.D., 1982, The opening of the Woodlark Basin, subduction of the Woodlark spreading system, and the evolution of northern Melanesia since mid-Pliocene time: *Tectonophysics*, v. 87, p. 253–277.
- Weissel, J.K., and Watts, A.B., 1979, Tectonic evolution of the Coral Sea Basin: *Journal of Geophysical Research*, v. 84, p. 4572–4582.
- Weissel, J.K., Watts, A.B., and Lapouille, A., 1982, Evidence for late Paleocene to late Eocene sea floor in the southern New Hebrides Basin: *Tectonophysics*, v. 87, p. 243–251. □

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