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Mantle Plumes: Their Identification Through Time

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Cover: The model of mantle plumes is modified after Figure 1 in N. Arndt (2000, Hot heads and cold tails, Nature, v. 407, p. 458–459), and is reprinted with the permission of *Nature*, copyright 2000, Macmillan Magazines, Ltd. Plumes are shown rising from the core mantle boundary or from an intra-mantle boundary. The former can either ascend directly into the upper mantle or stall at an intra-mantle boundary and spawn "plumelets." The Earth image used as a background was obtained from NASA (National Aeronautics and Space Administration). The bar diagram shows the distribution of well-established (in red) and probable (in black) mantle plume head events through time (modified after Figure 2 in R.E. Ernst and K.L. Buchan, Chapter 19, this volume).

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Rifts of the world

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ABSTRACT

Rifts are fault-bounded elongate troughs, under or near which the entire thickness of the lithosphere has been reduced in extension during their formation. They form in most tectonic settings, including above mantle plumes, and at all stages of the Wilson Cycle of ocean opening and closing. The purpose of this paper is to present an updated inventory of the rifts of the world both in graphic and tabular form. We have identified 290 rifts in Eurasia, 101 in Africa (including Madagascar), 11 in Australia, 1 in New Zealand, 81 in North America, 68 in South America, and 16 in Antarctica. These numbers are clearly an underestimation, because of (1) the ones we missed and (2) the ones that were too small to be included here. The greatest majority of rifts formed through passive mechanisms, i.e., without active mantle participation. In the future, it would be more helpful to consider rifts in terms of taphrogens, i.e., regions of intense extension, in which many rifts and grabens occur as a result of general lithospheric stretching, to be able to understand the tectonic regimes that give rise to rifting.

INTRODUCTION

The purpose of this paper is to present an updated inventory of the rifts of the world. The endeavor follows intensive efforts in the early 1970s to map and classify (Milanovskii, 1972) and in the mid-1970s to map and list the rifts of the world (Burke et al., 1978); there were further iterations by Milanovskii (1980, 1983a, 1983b, 1987) plus another in only map form nearly a decade later (Şengör, 1995). Although our inventory is still considerably larger than any hitherto published, it should be considered to be of a preliminary nature, because of the difficulty of adequately surveying the vast literature on the topic of rifts and because of the accelerating development in rift studies worldwide. We would therefore appreciate any criticism and any additional rift to be placed on our list. We would particularly welcome copies of publications concerning rifts not present in our list.

In the future, a list of *taphrogens,* defined herein as lithosphere-scale structures that are commonly formed from a linked system of rifts and grabens that stretch the lithosphere, will undoubtedly prove much more informative than a list of individual rifts for illustrating extensional phenomena in Earth history. By analogy, we commonly display orogens when we wish to illustrate convergent phenomena in Earth history and not individual nappes or folds (e.g., Şengör, 1990a, 1991). To try to do the latter would be a well-nigh impossible task. A list of nappes would be time- and energy-consuming to generate and too extensive to permit recognition of any underlying pattern. Attempts of limited usefulness of that sort resulted in the many mute terrane lists and maps that were so fashionable not that long ago (e.g., Howell, 1985, 1989; Leitch and Scheibner, 1987; Dallmeyer, 1989; Wiley et al., 1990). They are gradually being abandoned, as the geological community rediscovers that genetic entities represented by orogens (Kober, 1921) and orogenic systems (Stille, 1928; Şengör, 1990a)—while having a large component of human guesswork involved—still are im-

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mensely more informative and easy to question in their simplicity, elegance, and daring than a list of numerous empirical fault-bounded packages making inquisitive checking impossibly difficult (cf. Şengör, 1990a, 1990b, 1993a; Şengör and Dewey, 1990; Şengör et al., 1993; Şengör and Natal'in, 1996a, 1996b; Hansen, 1999).

In the following paragraphs, we review the concepts of *graben, rift,* and *taphrogen* with a view both to showing the basis of our mapping—i.e., what we mapped and what we left out—and to pointing out what needs to be mapped in the future. Although we have considered a few taphrogens, the limited time at our disposal did not allow us to be systematic. We think that mapping taphrogens needs to be undertaken in a systematic way in the future, if we are to understand the properties and interrelations of extensional systems.

CONCEPTS OF GRABEN, RIFT, AND TAPHROGEN

Rifts are fault-bounded elongate troughs, under or near which the entire thickness of the lithosphere has been reduced in extension during their formation (cf. Şengör and Burke, 1978, p. 419; Şengör, 1995, p. 53). They form in most tectonic settings, as shown subsequently herein, and at *all* stages of the Wilson Cycle of ocean opening and closing (Burke, 1978). They form sedimentary basins that preserve a record of the tectonic environment in which they originate and/or evolve much better than orogenic belts, though the range of environments forming in them is much more limited and contains much less diverse fauna and flora. Igneous activity is a common accompaniment to rifting, but again displays a more restricted range of types than found in the orogens. Rift metamorphism is modest compared with that accompanying orogenic processes, the most extreme cases being known from the "metamorphic core complexes" of the southwestern United States (Armstrong, 1982) and elsewhere (e.g., Burchfiel et al., 1992; Davis et al., 1996).

Many rifts do not survive as rifts in the geologic record. Commonly, when the extension factor (β, defined as the extended width divided by unextended width: cf. McKenzie, 1978a) grows beyond 3 (cf. Le Pichon and Sibuet, 1981), seafloor spreading tears the continent asunder and destroys the rift. Remnants of rifts forming continental margins are later commonly incorporated into orogenic belts and become deformed and metamorphosed. Some rifts, however, do not generate oceans and end their tectonic life during the rift stage. These get incorporated into the cemetery of fossil structures of the Earth as rifts, comparable to an individual who dies at infancy. These have been inappropriately called "failed rifts" in the geological literature, because they "failed to generate an ocean." What are generally called "failed rifts" are, in reality, perfectly successful rifts, *as rifts,* but are "failed oceans" and that is why "failed rift" is an inappropriate appellation.

Rift and *graben* generally are used interchangeably in the geological literature. Şengör proposed (1995) to confine the term *graben* to those structures that *do not* penetrate the lithosphere (i.e., "thin-skinned grabens" of Voight, 1974) and apply the term *rift* to those that *do* (i.e., "thick-skinned grabens"; see Voight, 1974, especially footnote 12; by "structure penetration," we here understand *the penetration of the extensional strain,* which creates different structures at different structural levels). Voight's proposition is supported by the history of these two terms.

Graben is a German word meaning a ditch or trench. It entered the language of geology via mining. In the miners' jargon, "grabens . . . are depressions or troughs in horizontal beds, which are much longer than they are wide" (Jacobsson, 1781, cited in Rosenfeld and Schickor, 1969). The word was not used commonly, though, until Suess (1883, p. 166) used it for strips of country subsided between two normal faults. The way Suess used it, especially in relation to the East African rift valleys (Suess, 1891, 1909), *graben* is equivalent to *rift.*

For Suess's meaning of *graben,* Gregory (1894, p. 295) introduced the term "rift valley" from the root "reve" meaning to tear apart or to pull asunder. *Thus, whereas the word* graben *is purely descriptive,* rift *involves an interpretation, i.e., extensional rupturing of a formerly continuous medium.* As originally used by the miners, "grabens" implied smaller and shallower structures than what are called "rifts." This distinction lives on in the collective memory of European geologists, although it is seldom given expression. Zeman (1979, p. 58; also see the references cited therein) is one of the few who has emphasized that distinction in print: "Some use the term [rift] for all grabens . . . , others believe the rifts to be associated with abyssal changes in the crust. . . . The author of this paper gives preference to the latter. Hence the rifts are grabens restricted to a thinned crust, accompanied by volcanism and connected with the elevated upper mantle by means of deep-seated faults (deep-seated grabens sensu St'ovícková, 1973)."

Examples of *grabens* in our—and the traditional—sense are the landslide-related graben systems that formed during the 27 March 1964 Prince William Sound earthquake in Alaska (Wilson, 1967; Voight, 1974) and the grabens of the Canyonlands National Park in Utah, which resulted from disintegration of the sedimentary section above the Upper Carboniferous gypsum-bearing Paradox Formation owing to flow down a gentle dip (McGill and Stromquist, 1974). It would greatly help to avoid confusion if one adhered to the graben versus rift distinction in the study of extensional structures. *In our compilation, we list only rifts, as defined herein, except where stated otherwise.* (However, if the word *graben* is part of a well-known designation for a specific rift, we have retained it in our compilation).

Naturally, using *rift* for lithosphere-penetrating structures and *graben* for those that do not go through the lithosphere robs our terminology of a neutral term to designate normal-fault-bounded troughs regardless of how deep they penetrate. We suggest that geologists use the term *extensional fault trough* or *V-trough* for such structures. Extensional fault troughs could be grabens or could be rifts. Their compressional counterparts could be called *compressional fault troughs* or *A-troughs,* and strike-slip counterparts then would be *strike-slip fault troughs* or *I-troughs.* If one side of a fault trough is delimited by an extensional fault and the other is bounded by a compressional fault (as in the case of many foreland and hinterland flexural basins), or one side by a strike-slip fault and the other by a normal or a thrust fault (as in many flower structures), one could then speak of a *hybrid fault trough.* Hybrid troughs could in turn be compressional strike-slip (AI-troughs) or extensional strike-slip (VI-troughs) (Fig. 1).

Currently, no term is generally employed to designate *regions of intense extension,* in which many rifts and grabens occur as a result of general lithospheric stretching. For comparable *regions of intense shortening* the term *orogen* has been in common use since Kober's (1921, p. 21) suggestion. A corresponding term for zones of intense extension is clearly needed, and this need has been felt ever since the word *graben* began to be used in the meaning of what we call a rift. Eduard Suess, who was the first to appreciate the existence of large regions of extension on Earth, wrote, "The investigation of a single sunken area or of a single line of subsidence does not lead us far. So long as each fold in a mountain chain was considered separately and every anticlinal of the Jura mountains was regarded as though it were the result of an independent linear elevation, further insight into the nature of folding generally was impossible. Just as the folds of a great chain are arranged according to universal laws, and as each of these is dependent on the neighboring folds and on the general structure of the chain, so in large areas we see lines of subsidence arranged in nets or systems which, taken together, indicate the position of a field of subsidence, and, like the folds of a mountain chain, are the effects of a common cause." (Suess, 1883, p. 165; in the English edition: Suess, 1904, p. 125.) The need for a handy term for regions of extension has led some to use those terms invented for compressional regions with extensional adjectives, such as "graben tectogen" (Illies, 1974a, p. 6) and "extending orogen" (e.g., Wernicke, 1981, 1985). But such terms are likely to lead to confusion as they seem to suggest the extension of a preexisting compressional structure rather than the extensional structure itself.

Şengör (1995) suggested that geologists use the term *taphrogen,* derived from Krenkel's (1922, p. 181 and footnote) term *taphrogeny,* meaning trough-building (from the Greek ταφρος = ditch or trench), to designate the extensional counterparts of orogens.[1] Thus, *taphrogens are lithospheric-scale structures, commonly formed from a linked system of rifts and grabens that stretch the lithosphere.* Advanced taphrogeny eventually leads to ocean formation (which may be called *thalassogeny.* Kober, 1921, p. 48: from the Greek θαλασσα = sea). If taphrogeny stops before producing ocean (i.e., before leading to thalassogeny), it causes subsidence and creates large basins overlying taphrogens (cf. McKenzie, 1978a). In other words, intracontinental taphrogeny leads to *koilogeny* (Spizaharsky and Borovikov, 1966, p. 113 and following: from the Greek κοιλος = hollow).

Owing to the need to recognize not only individual extensional structures, but also *patterns of structures* (i.e., whole taphrogens), Şengör (1995) proposed a hierarchical classification of rifts in the framework of taphrogens, which goes from pure geometry to dynamics (Fig. 2). His classification was primarily designed to facilitate considering observations not only from individual rift fragments preserved in the geologic record, but also from parts of larger patterns of rift groups in relation to one another and/or to other structures such as koilogens, thalassogens, and orogens. Owing to its hierarchical nature, Şengör's classification also discloses the environment and path of formation of a given rift. When the editors of the present volume asked us to prepare a list of the rifts of the world, they requested that every rift be put into its appropriate slot according to Şengör's scheme. In this paper, rifts are thus classified by using Şengör's letter and number notation. In most cases, we confined ourselves to kinematic and geometric aspects of a given rift. This approach was partly owing to our ignorance of the dynamic aspects of most rifts and partly because once a kinematic-geometric line is established in Şengör's scheme, the dynamic class in the classification into which a rift would fall is generally obvious.

However, when rigorously pursued, Şengör's classification leads up to the dynamic categories d1 or d2, namely, active and passive rifts, respectively (Şengör and Burke, 1978). It can be used as a sort of checklist in searching for ancient plumes, for the d1 category contains exclusively plume-related rifts. The present compilation shows, however, that the geometric categories can be more varied than indicated in Şengör's original classification. This complication results from the structural and the thermal state of the lithosphere at the time of rifting. However, the next stage, the kinematic categories, leads more safely either to the d1 category or the d2 category. The classification is more genetic than descriptive. As Gould (1989, p. 98) wrote, "classifications are theories about the basis of natural order, not dull catalogues compiled only to avoid chaos." An allegedly "descriptive" classification commonly generates an artificial air of finality and tends to choke further questioning. A genetic classification, by contrast, is nothing more than a hypothesis in the Popperian sense, "a theory of causal ordering" (Gould, 1986, p. 63), and invites criticism and eventual refutation.

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[1] Strictly speaking, only intracontinental orogens, collisional or otherwise. The following one-to-one comparison may make our meaning clear: (1) *Orogen:* intracontinental convergence; taphrogen: intracontinental extension. *Orogen:* continental collision; *taphrogen:* continental separation. *Orogen:* crustal thickening; *taphrogen:* crustal thinning. *Orogen:* intercontinental convergence (i.e., subduction); *taphrogen:* has no corresponding act. *Orogen:* point collision with subduction continuing on both sides of collided point; *taphrogen:* beginning extension at a point with no action on any side of that point.

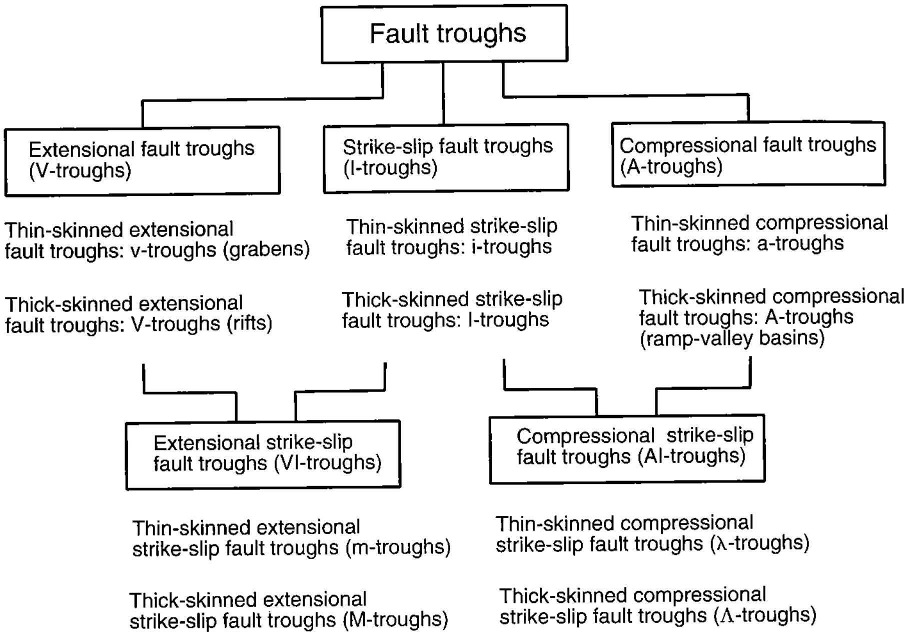

Figure 1. Terminology offered for discussion of fault-bounded troughs. The offered letter-based terminology has a mnemonic base, derived from the cross-sectional aspects of the troughs. Extensional fault troughs commonly have V-shaped cross-sections, bounded by one or two normal faults dipping basinward. Strike-slip troughs ideally generate basins with parallel, vertical sides. These could have been called H or I troughs. We chose I, because it more readily calls to mind the cross-sectional aspect of a strike-slip fault. Compressional troughs are bounded by thrusts verging towards the basin, calling to mind the shape of an A or a Λ. We chose A, to reserve λ for strike-slip/compression hybrids, as the lower case lambda has an upside-down v and a steep tail resembling a strike-slip fault cross-section. The scheme is self-explanatory and, if used in geological descriptions, may avoid much ambiguity or unnecessary verbosity. We have not used it in our Table 1, for it would have further complicated an already fairly complex listing. It is here offered for discussion. If it finds favour in the geological community, we hope to use it (or a revised form of it) in a comprehensive discussion of the world's taphrogens in a future paper.

ŞENGÖR'S CLASSIFICATION: A RESTATEMENT

The classification of rifts that Şengör (1995) proposed also embraces *groups of rifts,* i.e., taphrogens. It has three different categories that do not completely overlap, namely *geometric, kinematic,* and *dynamic.* In the following, the three different categories are identified with their initials, i.e., *g, k,* and *d,* respectively.

Geometric classification of rifts (see Fig. 2)

Rifts display five kinds of patterns of occurrence in map view (Şengör, 1983, 1995). From simplest to more complex, these are as follows:

(g1) Solitary rifts. *Solitary rifts* form small, fairly insignificant and very rare taphrogens and are extremely difficult to ascertain in the geologic record, because it is commonly hard to tell whether a given rift fragment is isolated or part of a larger taphrogen.

(g2) Rift stars. *Rift stars* (Cloos, 1939, p. 512) form when more than two rifts radiate away from a common center, building a fairly equant taphrogen. Rift stars are very common features of the structural repertoire of our planet today (cf. Burke and Dewey, 1973).

(g3) Rift chains. When several rifts are aligned end-to-end along linear or arcuate belts of rifting, they form *rift chains.* The East African rift system constitutes the best known active rift chain in the world.

(g4) Rift clusters. When several subparallel rifts occur in roughly equant areas, they are said to form a *rift cluster* (Şengör and Burke, 1978, p. 419). The two best-known active rift clusters in the world are the Basin and Range extensional area in North America and the Aegean Sea and the surrounding regions. The West Siberian taphrogen constitutes an inactive example of a rift cluster.

(g5) Rift nets. First recognized and named by Eduard Suess (1883, p. 165), *rift nets* constitute a rare pattern, which comes about when rifts form a roughly checkered pattern as in the Proterozoic basement of the East European platform or in the late Mesozoic in central north Africa. They resemble chocolate-bar boudinage and may have a similar origin, but more commonly, rift nets form in complex and rapidly shifting stress environments in which dominant extension directions change fast. Many rift nets in fact may represent two superimposed rift clusters.

Kinematic classification of rifts (see Fig. 2)

As rifts occur during all stages of the Wilson Cycle, the kinematic characteristics of the plate boundaries has been taken as a basis for classifying them according to the environment of the overall displacement and strain in which they form. There

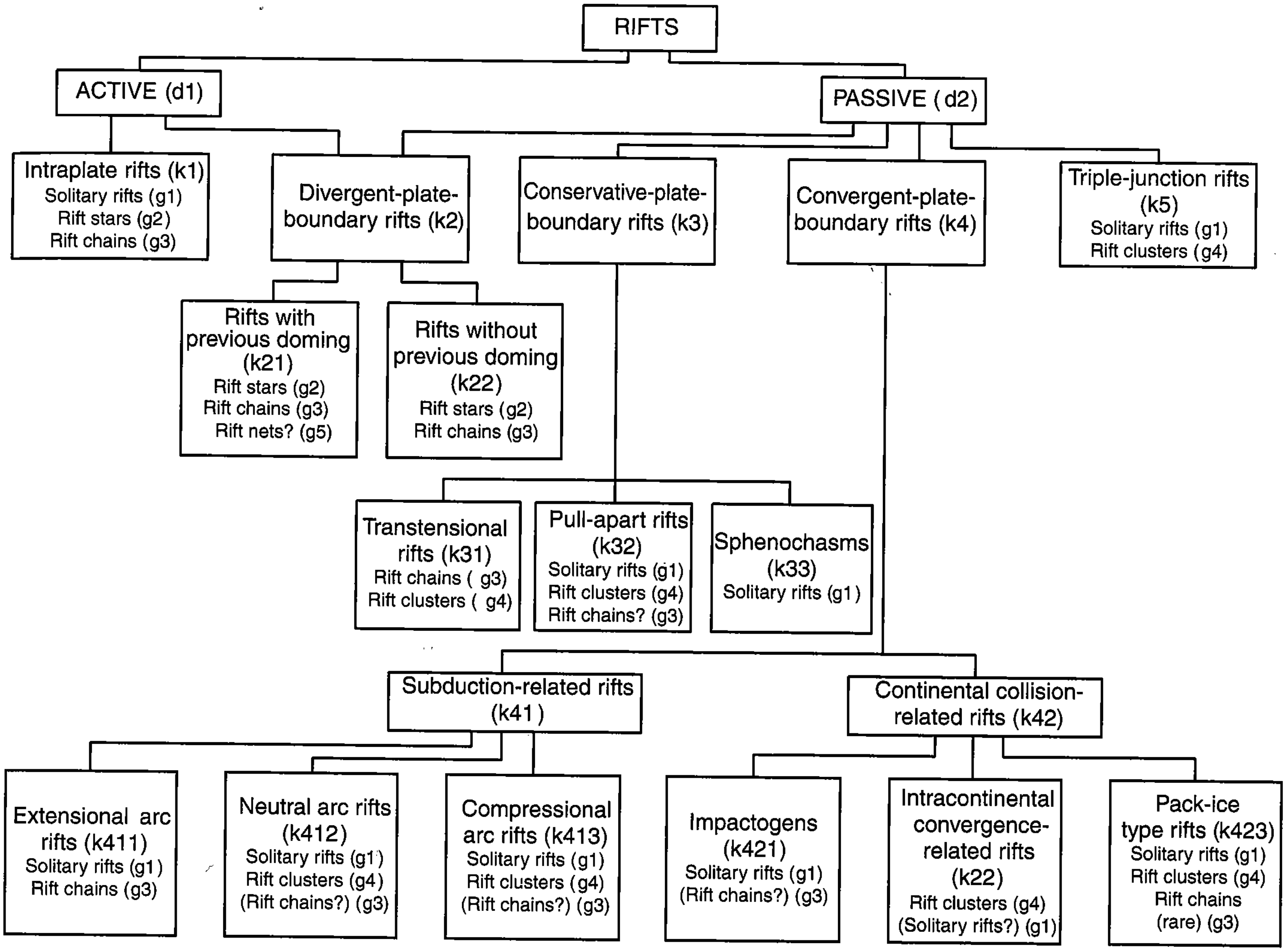

Figure 2. Classification of rifts (Şengör, 1995).

are three types of plate boundaries plus the plate interiors, with which four types of rift families correspond. In addition, problems of compatibility arise around some unstable triple junctions, commonly owing to involvement of hard-to-subduct buoyant lithosphere. Some of these problems lead to complex rifting that should be treated separately from the other four classes, thus creating a fifth kinematic class, herein called triple-junction rifts.

(k1) Intraplate rifts. Rifts surrounded entirely by undeformed lithosphere occupy this category. Such rifts are usually solitary, very small and very rare, and are difficult to detect in the geologic history. Some active examples are found in the northeastern United States in the Lake George and Lake Champlain rift structures (Burke, 1977).

(k2) Rifts associated with divergent plate boundaries. These rifts form as a direct consequence of plate separation along nascent divergent boundaries. All rifts along the East African rift system belong to this category. This category of rifts may be further subdivided into two classes as follows:

(k21) Rifts that form following an episode of doming. The divergent boundary along which rifts form is in this case preceded by an episode of lithospheric doming. The East African rift valleys are the most outstanding extant examples of such a situation (Burke, 1996). Rifts of Mesozoic age on the Atlantic margins of the Iberian Peninsula yield evidence for a comparable situation (Wilson, 1975).

(k22) Rifts that form with no prerift doming. In this case, rifts form without a prelude of uplift, as is the case in the Salton Trough in southern California. A good fossil example is the rifting of the Alpine Neotethys in the earlier Mesozoic (Stampfli and Marthaler, 1990).

(k3) Rifts that form in association with conservative plate boundaries. Conservative boundaries are, by definition, those along which neither extension nor shortening takes place. However, various reasons conspire to induce both extension and shortening to occur along considerable stretches of these boundaries (Christie-Blick and Biddle, 1985; Sylvester, 1988).

Rifts along conservative platê boundaries form in three different settings:

(k31) Transtensional conservative boundaries. If a conservative boundary is leaking because of a component of extension, it is called transtensional (Harland, 1971, p. 30 and especially Fig. 2). Many active rifts have a transtensional component, and fossil examples of such rifts may be recognized largely through the structures they contain or from their former bounding transform fault endings.

(k32) Pull-apart basins along conservative boundaries. Major strike-slip faults, the main structural expression of conservative plate boundaries, commonly have bends along them that either facilitate ("releasing bends": Crowell, 1974, Fig. 3) or obstruct ("restraining bends": Crowell, 1974, Fig. 3) movement along the strike of the fault. These bends may be primary, related to the initial nucleation of the fault, or secondary, formed through structural modifications imposed on a preexisting fault and/or system of faults. In both cases, extensional basins form along the releasing bends, in which the magnitude of extension equals the magnitude of cumulative strike-slip offset along the strike-slip fault since the formation of the releasing bend. Such basins are called "pull-apart basins" after Burchfiel and Stewart's (1966) apposite appellation, but the concept is much older. Crowell's (1974) fault-wedge basins are nothing more than special cases of pull-apart basins. Pull-apart basins come in all forms and shapes, notwithstanding the claim by Aydm and Nur (1982) that they display a constant aspect ratio at all scales.

(k33) Sphenochasms. Not all basins created by secondary extension associated with strike-slip faults are pull-apart basins. Some represent tears caused by either an asperity or differential drag along the strike-slip fault in one of the fault walls, in which the amount of extension changes from a maximum along the fault to zero at the pole of opening of the tear basin. Carey (1958, p. 193) called such wedge-shaped rifts that open toward a major strike-slip fault *sphenochasms* (from the Greek σφεν = corner, and χαω = to yawn).

(k4) Rifts that form in association with convergent-plate boundaries. A large family of rifts forms in association with convergent-plate boundaries. In this group, a first-order subdivision is between rifts associated with subduction zones and rifts associated with continental collision, although this scheme may artificially split some genetic groups, such as those rifts that presumably form owing to tension generated by excessive crustal thickening.[2] The usefulness of the present grouping is that it enables a rapid overview of the currently active rift environments and comparison with past ones.

(k41) Rifts associated with subduction zones. Three separate environments of rifting associated with subduction zones correspond with three different types of arc behavior, namely, extensional, neutral, and compressional arcs (Dewey, 1980; Şengör, 1990a).[3] In these environments, an enormous variety of rifts forms, and many evolve into oceans. In the following discussion, we consider only those that fail to generate oceans and get preserved as fossil rifts.

(k411) Rifts associated with extensional arcs. Once an arc begins extending, it generally splits along the magmatic axis (if such an axis is already in existence) and forms a small rift chain. Such a situation is today known from both the Okinawa rift and the Izu-Bonin arc system, where marginal basins are in the process of rifting. Such rifts generally do not get preserved intact in the geologic record, both because of the vicissitudes of the tectonic evolution of arcs involving common changes of behavior and because of later collisions with other arcs or continents. Preservation of rifts associated with extensional arcs in an uncompressed state takes place commonly when the associated arc switches from extensional behavior to neutral behavior.

In extensional arcs, rifts also develop orthogonal to the arc trend owing to the extension of the arc as it bows out in front of an expanding marginal basin (as, for instance, in Crete). This is similar to Carey's (1958) oroclinotath formation.

(k412) Rifts associated with neutral arcs. Neutral arcs are defined to have neither shortening nor extension across them. Therefore the only rifts that form in neutral arcs are those associated with arc-parallel strike-slip faults, which may be classified in the same way as the rifts that form along conservative plate boundaries. More complex rift basins may originate along such arc-parallel strike-slip faults, if the sliver in the forearc area (Jarrard, 1986, p. 235; "forearc plate" of Woodcock, 1986) disintegrates and its various pieces rotate about vertical axes.

Pull-apart basins in arcs are difficult to recognize. None of the major active strike-slip faults located in arcs has well-developed pull-apart basins along them (e.g., the Median Tectonic Line in Japan, the Atacama fault in the Andes, or the Philippine fault in the Philippine Archipelago), except the Andaman Basin that connects the right-lateral Sagaing and the Sumatra faults and that is likely floored by oceanic crust (cf. Hamilton, 1979). Also, the Sumatra fault may now be developing a pull-apart basin between 0 and 1 °N (Sich and Natawidjaja, 2000). Fossil and relatively undeformed examples of such basins have been inferred and mapped, however (e.g., the Chuckanut, Puget, and the Swauk basins in the state of Washington, in the northwestern United States: Johnson, 1985).

Sphenochasms along strike-slip faults in arcs are rarer still. Davis et al. (1978) have discussed two possible examples, the more recent of which may have created the "Columbia Embay-

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[2] We emphasize that we are very sceptical about "extensional orogenic collapse" under the weight of uplands alone. Everywhere it has occurred, an additional process, such as tectonic escape, seems to have aided it. Moreover, in many places where it is proposed to occur, the number of structures responsible for extension and the actual amount of stretching are far smaller than proposed (e.g., the Alps), and the direction of stretching is at variance with the solely gravity-driven extensional orogenic collapse model (e.g., the Betic Cordillera). Where it has indeed occurred, it was aided by lubricating the collapse faults by granite injection as in the Himalaya (e.g., Burchfiel et al., 1992).

[3] Jarrard's (1986) seven or even five different types of arc behavior are far too detailed to be applicable to a general survey of the historical geology of arcs and are therefore not used here. For a discussion, see Şengör (1990a, p. 66).

ment" by motion along the Straight Creek fault in the latest Cretaceous and the earliest Cenozoic.

(k413) Rifts associated with compressional arcs. In compressional arcs, crust commonly thickens and lithosphere thins, both by heating and by eventual delamination. The arc becomes shortened across, and elongated along, its trend. This elongation commonly generates rifts at high angles to the trend of the arc.

(k42) Rifts associated with zones of continental collision. Three different environments of rifting form associated with the collision of continents: (1) *lines of extension* that radiate from points at which collision commences; (2) *regions of extension* abutting against sutures, and (3) *nodes of extension* in areas of complex deformation in forelands and hinterlands shattered by collisions. Impactogens (k421), rifts forming in intracontinental convergence belts (k422), and pack-ice-type rifts (k423) correspond with these three environments, respectively.

(k421) Impactogens. Impactogens are rifts that originate as a result of tensional stresses set up in a continent when it is hit by a pointed promontory of another continent. The best example today is the Upper Rhine graben between Germany and France, which formed in the middle Eocene upon collision in the Alps. Impactogens are commonly solitary rifts, but several impactogens may form along a long front of collision, if more than one promontory collides with the opposing continent (e.g., the Oslo-Skagerrak rift and the Viking-Central rift in the North Sea along the Variscan collision front in northern Europe).

(k422) Rifts forming along intracontinental convergence belts. These rifts are similar in principle to those described under k413 (rifts associated with compressional arcs) and indicate the elongation of the orogen along its trend during postcollisional convergence. The north-trending grabens in southern and central Tibet, which formed as a consequence of the shortening and east-west elongation of the Tibetan high plateau following collision along the Indus-Yarlung suture represent the best active examples of these.

(k423) Pack-ice-type rift basins. When a continental collision generates first impactogens and then rifts related to ongoing intracontinental convergence, along with conjugate strike-slip faults that help the sideways elongation of the shortening region along the orogen, the whole deformed area becomes divided into rigid and semirigid blocks, in central Europe termed *Schollen* (see Dewey and Şengör, 1979, footnote 1), that move with respect to one another along compressional, extensional, and strike-slip boundaries similar to drifting pack ice. In such a setting, rifts and grabens form in diverse shapes and orientations, as best exemplified today by the *Schollen*-regime of central Europe (Şengör, 1995, esp. Fig. 2.10).

(k5) Triple-junction rifts. Triple-junction rifts form at or near unstable triple junctions, at which plate evolution dictates the generation of "holes" owing to failure to create subduction zones along a plate boundary, commonly because one or more plates meeting at the triple junction consist of buoyant lithosphere.

Dynamic (genetic) classification of rifts (see Fig. 2)

Rifts also may be classified according to the origin of forces that lead to rifting. Şengör and Burke (1978) proposed that stresses that cause rifting may be imposed on the lithosphere directly by the mantle beneath it or they may result from two-dimensional plate evolution. Accordingly, they termed these two modes of rifting *active* and *passive.* The proposal to call passive rifting "closed-system rifting" and active rifting "open-system rifting" by Gans (1987) is misleading, because it is not necessarily obvious with respect to which parameter the system is considered open or closed (crustal addition, geochemical reservoir tapped, plate-boundary network, or original sedimentary provenance). Consequently we avoid it here.

(d1) Active rifting. "Active rifting" is rifting caused by mantle upwelling associated with hotspots in the mantle (see Şengör, this volume). In such environments, rifting was originally thought to result from the tension created by the extrados stretching (i.e. stretching occurring along the outer arc of a concentric fold; in other words on the extensional side of the neutral surface) caused by doming (Cloos, 1939). Studies since Cloos (1939) have shown that although doming in some instances may be sufficient to *initiate normal faulting,* it is not sufficient to *maintain rifting* and to create anything like our present rift valleys in Africa or the Rhine graben.

Two views have been advanced to explain the origin of the extension not related to extrados extension of domes rising above hotspot jets. One ascribes the rifting to basal shear stresses induced by a spreading plume head beneath a dome. The other holds the potential energy of the rising dome responsible for driving the rifting (see Şengör, this volume). All of these factors probably do contribute to maintaining the active rifting process at its habitually slow pace of considerably less than 1 cm/yr.

(d2) Passive rifting. Passive rifting refers to a mode of rifting in which the mantle under the rifting area plays only a passive role. In the passive-rifting mode, extension is caused by the two-dimensional motions of the lithospheric plates. In this mode of rifting, there is no prerifting doming related to a hotspot (Şengör and Burke, 1978). Kinematic mechanisms previously reviewed under the headings k22, k31, k32, k33, k411, k412, k413, k421, k422, k423, and k5 all may form rifts in a "passive-rifting mode."

There is only one kind of rift this classification does not consider: rifts that form by propagating from an already existing rift. Because propagation may take many forms, we thought it might be sufficient to indicate such rifts with the notation d2 to indicate their passive mode of opening. Figure 2 can be used as a "flow chart" to follow the evolutionary histories of the various kinds of rift basins reviewed in the following sections.

The two dynamic categories of Şengör's (1995) classification have the property of assigning rifts into two main classes that may also be named *plume related* and *plate-boundary related.* So far as we know, mantle dynamics directly interferes

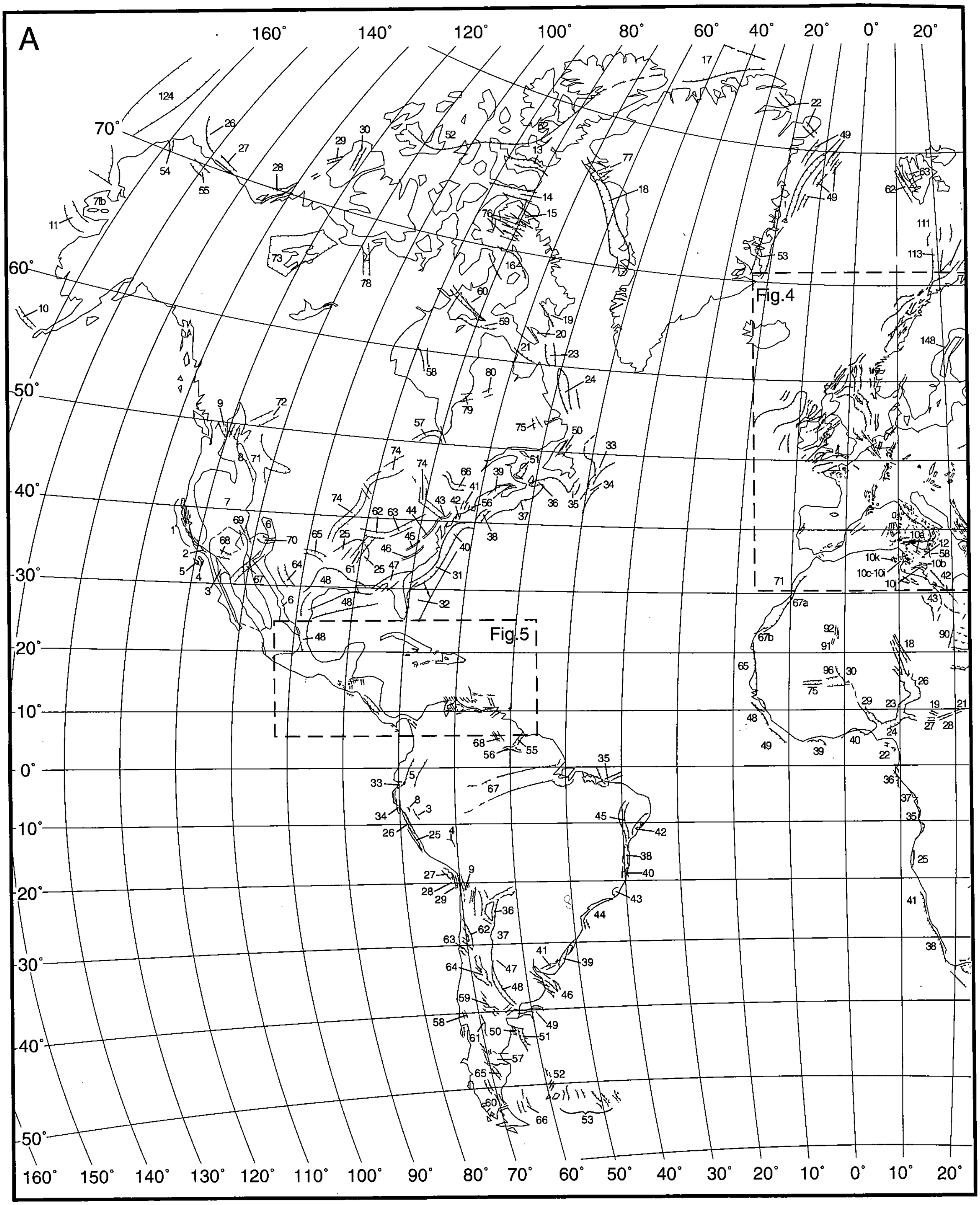

Figure 3 (this and following page). Rifts of the world, excluding Antarctica. Rifts of Antarctica are shown in Figure 6. Numbers refer to Table 1.

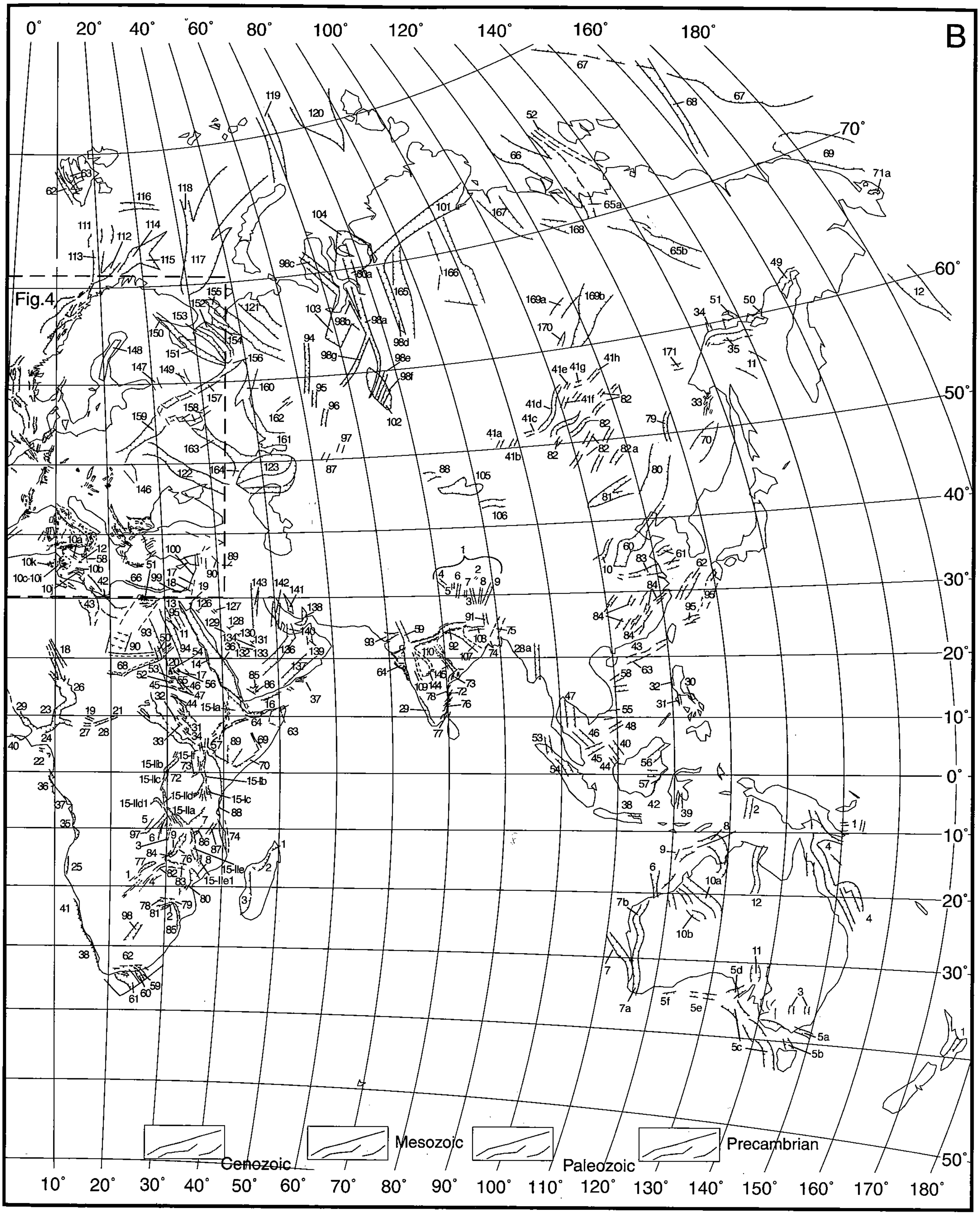

Figure 3 (*continued*).

with the behavior of the lithosphere via convection. This convection seems multiscaled and both maintains the plate motions and generates plumes originating at various depths and having different degrees of vigor (see Burke, 1996; Csrepes and Yuen, 2000). All intraplate tectonism—so far as it is not related to loads put on top of the lithosphere and so far as it is not related to bending the lithosphere near plate boundaries or unrelated to sinking heavy objects along old subduction or collision zones—appears related to the activity of the plumes. Another class of purported source of intraplate deformation is membrane stresses that allegedly result either from the wandering of plates on a nonspherical Earth (Turcotte and Oxburgh, 1973; Turcotte, 1974) or from the secular thermal shrinking of the planet (Solomon, 1987). It is unlikely that in the time scales involved in moving the plates a quarter of the way around the Earth or in cooling the Earth sufficiently to create serious mismatch between lithospheric curvature and its support, stresses can be created that give rise to fractures penetrating the lithosphere (cf. Burke and Dewey, 1974; Burke et al., 1981, p. 828–829).

For these reasons, *all hotspots must be related only to mantle plumes,* although the term *hotspot* itself has no genetic connotations whatever and simply means "intraplate magmatism." Kevin Burke (2000, written communication) has insisted on this nongenetic aspect of the term and has suggested that hotspots may result from magmatic activity associated with (1) rifts, (2a) shallow plumes of the kind that probably gave rise to the swell-and-basin topography of Africa, (2b) deep plumes of the kind that has created the Afar triple junction (see Burke, 1996), and (3) an uncertain origin. Despite that, every time Burke had occasion to discuss the origin of hotspots, he has only referred to the activity of the mantle, specifically to plumes (e.g., Burke and Wilson, 1976; Burke and Kidd, 1980; Burke et al., 1981; Burke, 1996). This is in agreement with Şengör's result (this volume) that if a rift is not related to the activity of a plume, it must then be related to the activity of a plate boundary or a plate-boundary zone. That is why one can think of those rifts that form by active-mantle processes as plume-related rifts and those in whose formation mantle dynamics plays no direct role as plate-boundary rifts (see Şengör and Burke, 1978; because, with the exception of sporadic impact-related magmatism, we are unaware of any significant magmatism on Earth that is definitely related neither to plumes, nor to plate boundaries, nor to plate-boundary zones, Burke's third category i.e., those rifts whose origin is uncertain, we leave out of discussion now).

PRINCIPLES UNDER WHICH THE PRESENT LIST WAS COMPILED

An inventory of the rifts of the world is presented in graphic form in Figures 3–6 and in tabular form in Table 1. Table 1 lists only true rifts (as defined by Şengör) and omits grabens as already defined (though if "graben" is a part of the name of a rift, we retain it) and what is listed is shown in Figures 3–6. We incorporated into our list only those rifts that are still recognizable as rifts. These exclude backarc basins but include some gently compressed rifts, and "gentle compression" in some cases may involve a total of 10 km shortening as in the case of the Benue rift. The criterion is that the structural inferiority of the rift basement with respect to its shoulders should not be inverted by the subsequent shortening. The reader will find inconsistencies in our usage commonly introduced by force of habit—if we have been used to calling something a rift, we are likely to have included it, such as the Soria basin in Spain—notwithstanding the thrusts it has—and the Benue—although it may even have had subduction! We think that the number of such examples is so small as not to destroy the uniformity of the characteristics common to the rifts we list in Table 1. Here again we invite criticism to improve Table 1.

We have indicated a few taphrogens—those the reader will recognize without much difficulty. But Table 1 should by no means be considered to include an exhaustive list of taphrogens. Quite the contrary: it includes only a few. The identification of the rifts in taphrogens also reflects the experimental nature of the exercise: In east Africa, we denoted the two major subtaphrogens by Roman numerals, in the Basin and Range we did not, because the further division into rifts was not indicated.

Figures 3–6 are only a guide to the whereabouts of the rifts listed in Table 1 and show their shapes only roughly. They are not meant to be tectonic maps of rifts. They are only index maps and are not reliable for a statistical analysis of rift trends. If used for such a purpose, they would give a rough idea globally, but in many regions might mislead the statistician.

Both in Table 1 and Figures 3–6, *age of a rift* means age of first rifting. This is commonly the age of main rifting, but in some regions, this is not so, for example in some rifts in northwestern Europe. For most rifts, we have not listed episodes of subsequent rifting, but in this approach again we have not been consistent. The reader will find a number of episodes of rifting listed for some entries. Similarly, for some entries, additional information is supplied in footnotes. We have done this where we encountered problems in establishing some aspect of the rift under consideration or when we felt compelled to deviate from some common usage or practice, or where we felt additional information was necessary for the justification of our assignment of it to one of Şengör's (1995) classes. Also, for a few rifts, our sources disclosed no names, and we had to invent names for them; how we did this is always explained in a footnote. Because taphrogens were not recognized before, we had to invent names for them too. We adhered to the tradition of using the names of ancient peoples and places derive the names. The source and compass of these names are also given in footnotes.

References are given to enable the reader to locate the rift, to get an idea of its shape and age, and to be led to further sources. For most rifts, more than one reference is provided. For some, we had to make do with a single reference. Generally, the single references we chose contain abundant information. In some instances, we cite numerous references for two prin-

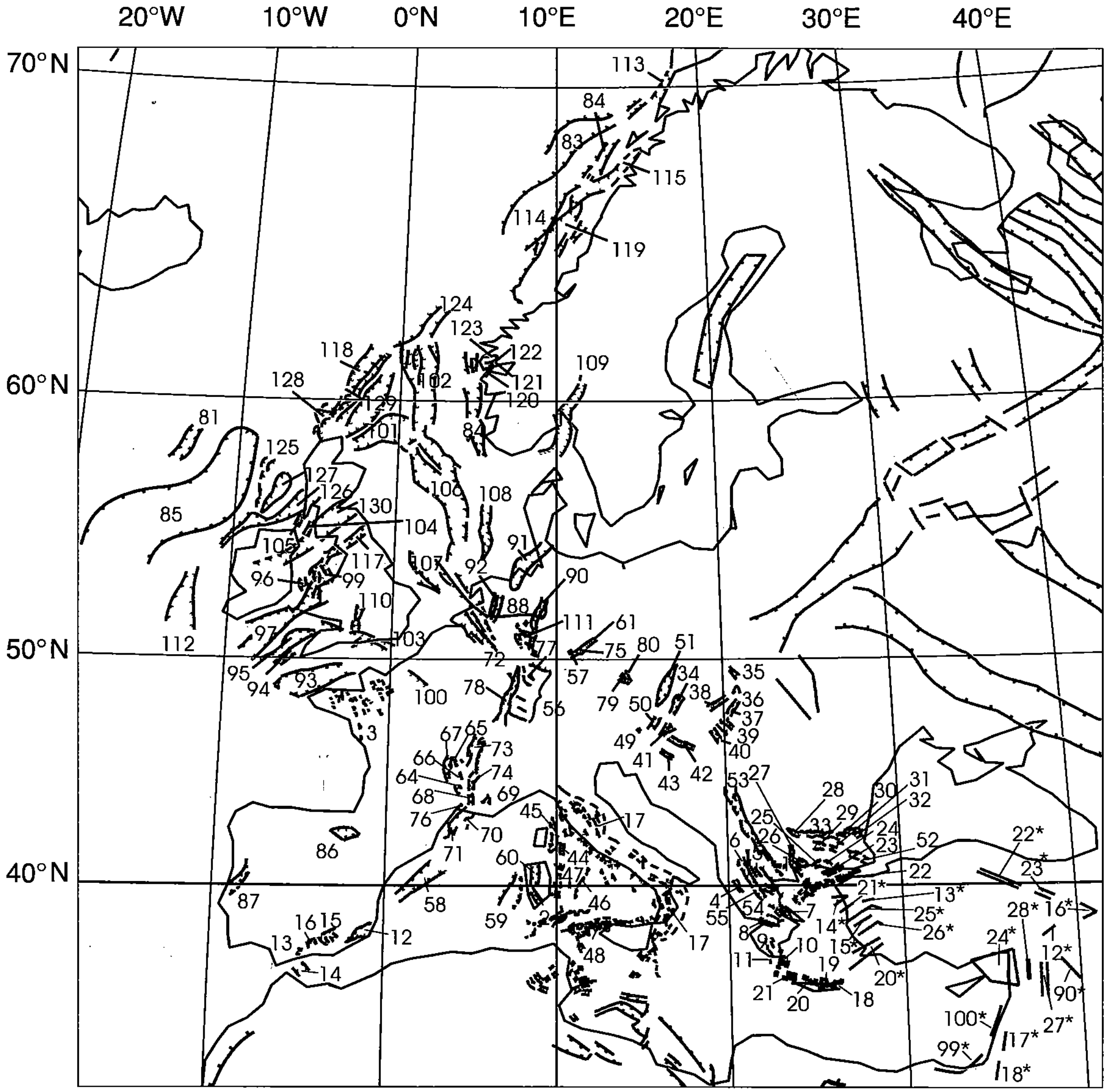

Figure 4. Rifts of western Europe and Turkey (for global context, see Fig. 3). The Hammersfest and Bjørnø rifts are off this map along the northern edge (they appear in Fig. 3). The details of the Turkish rifts appear in the Asian part of Table 11. Numbers refer to Table 1 entries.

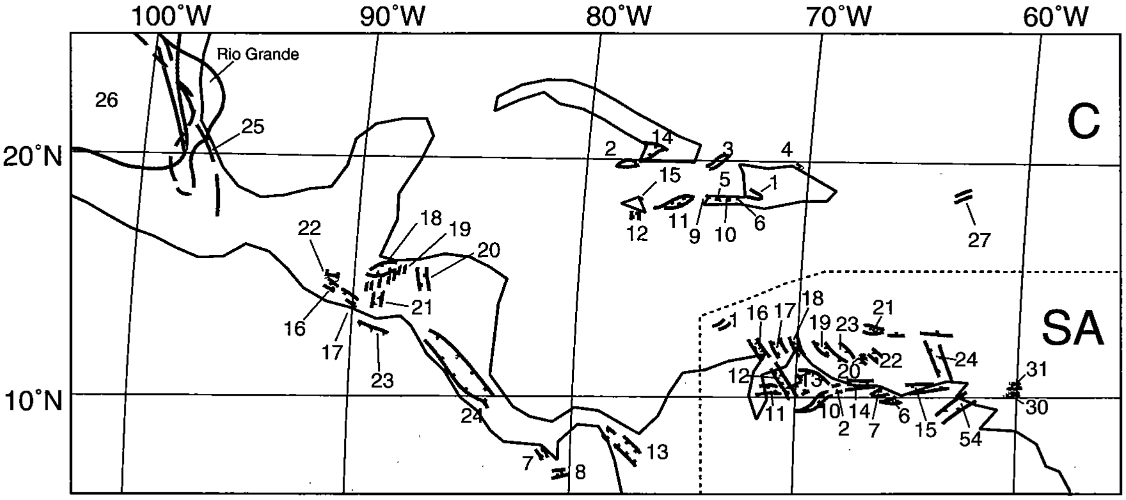

Figure 5. Rifts of the Caribbean and Central America (for global context, see Fig. 3). Part of diagram identified as SA contains rifts whose details appear in the South American part of Table 1, and the part identified as C contains rifts from the Caribbean and Central America list of Table 1. Numbers refer to Table 1.

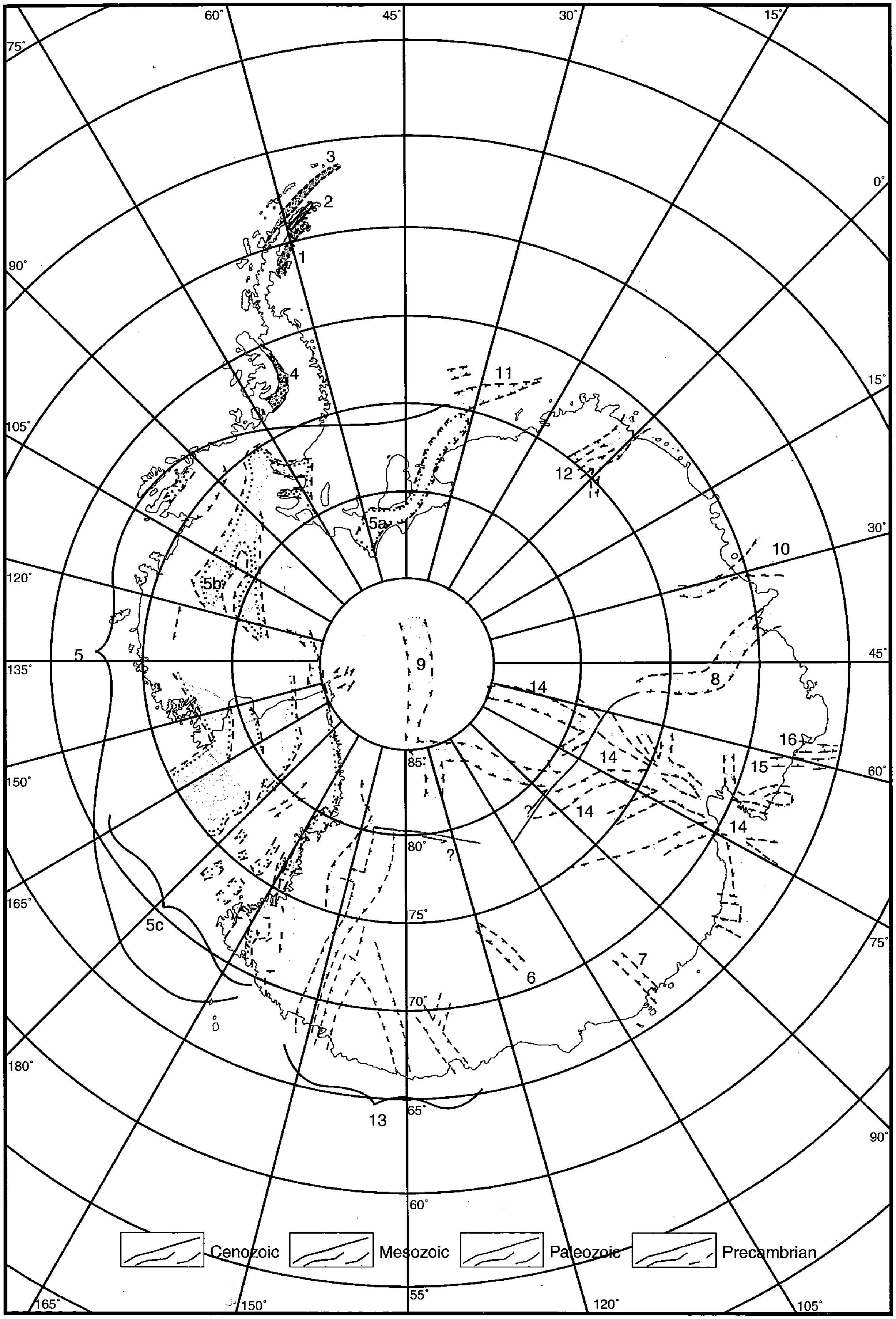

Figure 6. Rifts of Antarctica. Numbers refer to Table 1. A number of rifts along Antarctic continental margins known from cross-sectional data only are not shown.

cipal reasons: Either the feature under consideration has not been described completely in a few sources, or it is so large as to preclude having a few comprehensive sources devoted to it solely. Some of the taphrogens we list fall under the latter category.

The place of a rift in Şengör's (1995) classification is not infrequently our guess on the basis of a quick review of the principal traits of its geologic history. Some have been assigned slots by association, and others, by tectonic position. Naturally, only those rifts we are closely familiar with could be classified with some measure of confidence. The reader should view the assigned classes mostly as educated guesses based on flimsy data provided to form a starting point for a fruitful discussion.

As we have emphasized herein, this is a preliminary list, originated in haste. We hope to improve it and make it eventually a basis for mapping taphrogens on the face of the Earth. We would therefore be grateful for any criticism and additional pieces of information.

ACKNOWLEDGMENTS

Richard Ernst and Ken Buchan commissioned this paper—which Mary Lou Zoback has been for some years urging us to write—and made sure that it met the deadlines. We thank them for their confidence and patience. Kevin Burke provided an excellent review and only time pressure prevented us from incorporating all of his detailed comments into the final version. Mehmet Sakinç was our paleontological consultant as we surveyed the world-rift population. We thank Xavier Le Pichon for alerting us to the new Orsay work along the North Anatolian fault basins and establishing contact with Olivier Bellier and S. Över (via A. Poisson), who kindly sent us offprints. Taras P. Gapotchenko helped with the formatting of tables. We thank Rachelle Lacroix and Ken Buchan for their extensive work for finalizing the rifts maps and Figures 3–6 in digital form, and Richard Ernst for touching up—in the case of Figure 1 redrafting from our sketch—some of our figures. Richard also provided lists of references that we used to check and expand our original list. GSA copy editor Mary Eberle deserves our and our readers' gratitude for doing an extremely conscientious copy-editing job on a very difficult typescript; in particular for making sure of the completeness and correctness of the references cited. However, we alone must accept responsibility for all the remaining infirmities of the final product. Irina Natalina and Oya Şengör cheerfully accepted a second place in our lives with respect to the terrestrial rift population while this catalogue originated. H.C. Asım Şengör was responsible for establishing e-mail contact between Richard Ernst and A.M.C. Şengör.

(References begin on page 456)

TABLE 1. RIFTS OF THE WORLD

No.	Name[1]	Location (bounding longitude and latitude)[2]	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans[3]								
1	Lake Koronia–Lake Volvi graben system	23°E and 23°40′E, 40°40′N	E-W	50	10 (max)	Holocene	k33?, g1	Soufleris et al. (1982), Schröder (1986)
2	Campidano	8°30′E and 9°10′E, 39°10′N and 39°50′N	NW-SE	80	15	Quaternary	k422,[4] g1 or k32, g1	Carmignani et al. (1989), Catalano et al. (1989, Fig. 6)
3	Rift cluster of Bretagne (~20 full grabens and >20 half grabens)	0° and 4°30′W, 46°30′N and 49°N	E-W (long axis of cluster) N-S to NNW-SSE (individual rifts)	350 20–25 (individual rifts)	100 (avg) <10 (individual rifts)	Pliocene–Quaternary	k423, g4	Philip (1980), Bousquet and Philip (1981)
4	Ioannina graben	20°50′E, 39°40′N	NNW-SSE	80	20 (max)	Pliocene	k33?, g1	Institut de Géologie et Recherches du Sous-Sol et Institut Français du Pétrole (Mission Grèce) (1966, Fig. 101), Aubouin (1973), Schröder (1986)
5	Florina graben	21°10′E and 22°15′E, 40°N and 41°N	NNW-SSE	130	20	Pliocene	k33, g1	Aubouin (1973), Schröder (1986)
6	Lake Ohrid–Grevenà basin	20°30′E and 20°50′E, 39°45′N and 41°10′N	NNW-SSE	170	45 (max)	Pliocene	k33, g1	Aubouin (1973), Schröder (1986)
7	Gulf of Évvoia (Euboea; also known as Locris–Atalante Channel graben)	22°E and 24°E, 38°N and 39°N	NW-SE	200	15	Pliocene	k32, g1	McKenzie (1978b), Schröder (1986), Roberts (1988)[5]
8	Gulf of Corinth	21°50′E and 23°15E, 37°50′N and 37°20′N	ESE-WNW	130	30 (max)	Pliocene	k32, g1	Defaure et al. (1979), Jackson et al. (1982), Schröder (1986), Lyon-Caën et al. (1988)
9	Eurotas Valley (or Sparta graben)	22°10′E and 22°40′E, 36°50′N and 37°35′N	NNW-SSE	85	<10	Pliocene	k411, g4 and k32, g4	Schröder (1986), Lyon-Caën et al. (1988)
10	Gulf of Laconia	22°20′E and 23°E, 35°50′N and 36°50′N	NNE-SSW	120	35	Pliocene	k411, g4 and k32, g4	Schröder (1986), Lyon-Caën et al. (1988)
11	Gulf of Messenia (also known as Kalamata graben)	21°50′E and 22°15′E, 36°15′N and 37°15′N	N-S	135	40	Pliocene	k411, g4 and k32, g4	Schröder (1986), Lyon-Caën et al. (1988)
12	Murcia basin	0°30′W and 2°W, 37°20′N and 38°20′N	ENE-WSW	170	75 (max)	late Miocene	k32, g1	Rios (1977), Alvarado (1980), Bousquet and Philip (1981), Giese (1981), Lukowski et al. (1988)
13	Malaga basin	4°30′W, 36°43′N	E-W	30	12	late Miocene	k32, g1	Sanz de Galdeano and Lopez Garrido (1991)
14	Western Alboran basin	3°15′W and 5°W, 35°15′N and 36°20′N	NW-SE	110	70	late Miocene	k32, g1	Rios (1977), Şengör (1993)

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[1] A question mark (?) by the name of the rift indicates uncertainty as to whether the structure in question is a rift or just a graben.

[2] For rifts that are oriented north-south (N-S), only one longitude is given; for rifts oriented east-west (E-W), only one latitude is given. If a rift is too small for bounding longitudes and latitudes to be meaningful, the coordinates of a single point in the rift, preferably close to its center, are given.

[3] For geologic evolution and taphrogeny in Europe in general, see Ager (1980) (a beginner's text), Anonymous (1980), Cogné and Slansky (1980), Peive et al. (1981, 1982), Melchior (1985), Ziegler (1988, 1990), and Blundell et al. (1992).

[4] We prefer the first interpretation (see Catalano et al., 1989, Fig. 6).

[5] This is an unpublished thesis. Only a generalized summary out of it was published. We prefer the thesis itself owing to its excellent documentation of the neotectonics of the Atalante Channel.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
15	Guadix and Baza basins	2°30′W and 3°30′W, 37°N and 38°N	ENE-WSW (general) NNW-SSE (individual fault-bounded troughs)	100	30 (avg)	late Miocene	k32, g4	Rios (1977), Alvarado (1980), Bousquet and Philip (1981), Giese (1981)
16	Granada basin	3°50′W, 37°10′N	NNW-SSE	40	50	late Miocene	k32, g1	Rios (1977), Alvarado (1980), Bousquet and Philip (1981), Giese (1981)
17	Internal Apennines[6]	10°E and 16°15′E, 38°N and 44°N	NW-SE	800	200 (avg)	late Miocene	k411, g3, g4	Suess (1872), Kastens et al. (1988), Incoronato and Nardi (1989), Patacca and Scandone (1989), Sartori and ODP Leg 107 Scientific Staff (1989), Kastens and Mascle (1990), Bartole et al. (1991), Bigi et al. (1991),[7] Lavecchia and Stoppa (1991), Serri et al. (1991), Casero et al. (1988[1992]), Mariani and Prato (1988[1992]), Torre et al. (1988[1992]), Şengör (1993b)
18	Sitia(?)	26°10′E, 35°12′N	NE-SW to E-W	35	7	late Miocene	k411, g4	Le Pichon and Angelier (1979)
19	Iraklion	25°E and 25°20′E, 35°06′N and 35°24′N	N-S	24	25	late Miocene	k411, g4	Le Pichon and Angelier (1979)
20	Khania-Rethymnon-Messara-Ierapetra graben system	23°50′E and 24°50′E, 35°15′N and 35°30′N	E-W (general) E-W (Khania) NW-SE (Rethymnon) E-W (Messara) NE-SW (Ierapetra)	200	15–18 (avg)	late Miocene	k411, g4	Le Pichon and Angelier (1979)
21	Strait of Antikithira (including rift trough of Gulf of Kisamos)	22°30′E and 23°45′E, 35°15′N and 36°30′N	NNE-SSW	120	100 (individual rift troughs, ~10)	late Miocene	k411, g4	Le Pichon and Angelier (1979), Lyon-Caën et al. (1988)
22	Saros rift–Anatolian trough (also known as North Aegean trough)	23°30′E and 27°E, 40°45′N and 41°30′N	ENE-WSW	700	100 (max at W end) 20 (min at E end)	late Miocene	k31, g3	Lalechos and Savoyat (1977), Lybéris (1984), Roussos and Lyssimachou (1991), Tüysüz et al. (1998), Yaltırak et al. (2000)[8]
23	Enez	25°20′E and 27°E?, 40°45′N and 41°15′N	ENE-WSW	200	20	late Miocene	k31, g3	Kopp et al. (1969), Lybéris (1984), Yılmaz and Polat (1998)
24	Komotini	25°10′E and 25°45′E, 41°N	ENE-WSW	80	20 (max)	late Miocene	k33, g3	Lybéris (1984), Schröder (1986)
25	Kavala-Xanthi	24°30′E and 25°10′E, 41°N	ENE-WSW	100	20	late Miocene	k33, g3	Aranitis (1977), Armour-Brown et al. (1977), Lybéris (1984), Schröder (1986)

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[6] This is the classic taphrogen, which inspired Eduard Suess in 1872 to the interpretation that some mountain belts internally collapse along normal faults while shortening continues along the outer periphery (see, especially, Suess, 1883, p. 178–179). In the Vavilov and Marsili basins, the taphrogen ruptured completely so as to allow the formation of oceanic crust. The "Internal Apennines" include the continental northern Tyrrhenian Sea north of lat 41°N, which is nothing more than a southward-fanning sphenochasm.

[7] This is an outstanding tectonic map (in six sheets, scale 1:500 000) accompanied by a Bouguer gravity map (in three sheets, scale 1:500 000), which together give a very adequate idea of the structure of the Tyrrhenian Sea taphrogen. Maximum gain could be derived if the reader consults the other references cited on the Internal Apennine rifts with this map at hand.

[8] Although we find it difficult to agree with the escape model presented in this paper, it nevertheless contains much useful data.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
26	Drama	24°08′E, 41°09′N	NW-SE	60	10 (avg)	late Miocene	k33, g3	Armour-Brown et al. (1977)
27	Dzerman-Struma–Strymon-Serres graben system	23°E and 24°30′E, 40°15′N and 42°15′N	N-S NNW-SSE (in the S)	250	15 (avg)	late Miocene	k33, g3	Aranitis (1977), Armour-Brown et al. (1977), Ivanov and Nikolov (1983), Lybéris (1984), Schröder (1986), Durand-Delga et al. (1988)
28	Sofia basin	23°20′E, 42°40′N	NW-SE	30	10	late Miocene	k33, g3	Gocev et al. (1974)
29	Plovdiv basin (W part of "Thracian basin")	24°45′E, 42°10′N	E-W	60	30	late Miocene	k33, g3	Boyanov and Yusifov (1986)
30	Yambol depression	26°30′E, 42°29′N	ESE-WNW	50	20	late Miocene	k33, g3	Boyanov and Yusifov (1986)
31	Maritza trough (E part of "Thracian basin")	25°35′E, 42°N	ESE-WNW	50	50	late Miocene	k33, g3	Boyanov and Yusifov (1986)
32	Burgas trough	27°28′E, 42°30′N	E-W	50	20	late Miocene	k33, g3	Boyanov and Yusifov (1986)
33	Sub-Balkan graben system[9]	23°45′E and 26°19′E, 42°40′N	E-W	200	15 (max) <5 (min)	late Miocene	k33, g3	Roy et al. (1996), Tzankov et al. (1996)
34	Little Hungarian Plain and Danube basin	16°10′E and 18°E, 46°50′N and 48°45′N	NE-SW	180	45 (avg)	Pannonian (late Miocene)	k31, g1? or k32, g1? (or even k5, g3?)	Nagymarosy (1981), Bérczi et al. (1988), Royden (1988), Rumpler and Horváth (1988), Tomek and Thon (1988)
35	Transcarpathian depression	21°30′E and 23°E, 48°N and 49°10′N	NW-SE	120	25	Pannonian (late Miocene)	k31, g1? or k32, g1?	Rudinec et al. (1981), Bérczi et al. (1988), Royden (1988), Tomek and Thon (1988),
36	Nyírség basin	21°30′E and 23°E, 47°50′N and 48°10′N	NE-SW and NW-SE (triangular)	80 (NE-SW)	110 (NW-SE)	Pannonian (late Miocene)	k5, g3	Bérczi et al. (1988), Royden (1988)
37	Derecske basin	22°10′E, 47°N	NE-SW	60	20 (avg)	Pannonian (late Miocene)	k31, g1?, or k32, g1?	Bérczi et al. (1988), Royden (1988), Rumpler and Horváth (1988)
38	Jászság basin	19°50′E and 21°15′E, 47°N and 48°N	NE-SW	120	25 (avg)	Pannonian (late Miocene)	k31, g1 or g3;or k32, g1 or g3	Bérczi et al. (1988), Royden (1988)
39	Békés depression	20°55′E and 21°30′E, 46°30′N and 47°N	NNW-SSE	80	60	Pannonian (late Miocene)	k33, g4	Bérczi et al. (1988), Royden (1988)
40	Makó trough (or Makó-Hódmezovásárhély Trench)	20°E and 21°E, 45°45′N and 46°45′N	NNW-SSE	100	50	Pannonian (late Miocene)	k33, g1 or g4	Nagymarosy (1981), Bérczi (1988), Bérczi et al. (1988), Royden (1988)
41	Zala basin	16°E and 17°30′E, 46°15′N and 47°N	E-W and NNE-SSW (star-shaped)	140 (E-W) 60 (N-S)	20 (avg)	Pannonian (late Miocene)	k31, g2,or k32, g2[10]	Nagymarosy (1981), Royden (1988), Rumpler and Horváth (1988)
42	Drava trough	17°E and 18°E, 45°45′N and 46°15′N	NW-SE	123	20	Pannonian (late Miocene)	k31, g3,or k32, g3[10]	Nagymarosy (1981), Royden (1988), Rumpler and Horváth (1988)
43	Sava basin	16°E and 17°E, 45°15′N and 45°45′N	NW-SE	80	18 (max)	Pannonian (late Miocene)	k31, g3,or k32, g3[10]	Royden (1988), Rumpler and Horváth (1988)
44	Montecristo basin	10°15′E, 41°20′N and 42°N	N-S	90	<10	late Miocene	k411, g3	Bigi et al. (1991)

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[9] Contains the following grabens, from west to east: Sarantsi, Kamartsi, Mirkovo, Srednogorie (Zlatitsa), Karlovo, Sheinovo, Vetren (Muglij), Tvarditsa, and Sliven.

[10] See especially Figure 1 in Royden (1988).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
45	Corsican basin	9°30′E and 10°E, 41°20′N and 43°N	N-S	200	30	late Miocene	k411, g3	Bacini Sedimentari (1979), Bigi et al. (1991)
46	Cornaglia basin (also referred to as Cornaglia Terrace)	10°30′E and 11°20′E, 39°N and 41°N	N-S	300	90	late Miocene	k411, g3	Kastens et al. (1988), Catalano et al. (1989), Robertson et al. (1990), Bigi et al. (1991)
47	Sardinia basin	10°E and 10°30′E, 39°N and 41°N	N-S	350	35 (max) 20 (avg)	late Miocene	k411, g3	Kastens et al. (1988), Catalano et al. (1989), Robertson et al. (1990), Bigi et al. (1991)
48	Sardinia Channel rift cluster	7°30′E and 13°30′E, 37°N and 40°N	ENE-WSW individual rifts: ENE-WSW (in N and NNW); N-S and NNE-SSW in S	600 (whole cluster) 25–200 (individual rifts)	220 (whole cluster) 90 to <10 (individual rifts)	middle Miocene	k32, g4 and k422, g4	Catalano et al. (1989), Bigi et al. (1991)
49	Lavant Valley basin(?)	14°50′E, 46°50′N	NNW-SSE	25	6	middle Miocene	k32, g4	Fuchs (1980, p. 471–475), Tollmann (1985, p. 577–583),[11] Gutdeutsch and Arıç (1988)
50	Steyrian basin (also known as Graz basin)	15°40′E and 16°10′E, 46°30′N and 47°15′N	NNE-SSW	90	35 (max) 20 (avg)	middle Miocene	k31, g1	Fuchs (1980, p. 462–471), Tollmann (1985, p. 558–576),[12] Royden (1988)
51	Vienna basin	16°30′E and 17°15′E, 47°50′N and 48°45′N	NE-SW	100	30	middle Miocene	k32, g1	Jíricek and Tomek (1981), Royden (1985), Gutdeutsch and Arıç (1988), Wessely (1988), Nemcok et al. (1989), Fodor et al. (1990)
52	Ergene (also known as Thrace basin)[13]	26°30′E and 28°E, 39°N and 40°50′N	NW-SE	125	~30	early to middle Miocene?	k31, g3	Kopp et al. (1969), Sakınç et al. (1999)
53	Vardar–Gulf of Thérmai (also Axios–Gulf of Thérmai)	21°E and 24°E, 39°N and 44°N	NNW-SSE	520	100 (max)	early middle Miocene (Badenian)	k33, g3	Sikosek (1974), Aranitis (1977), Schröder (1986), Dumurdzanov et al. (1997)
54	Larissa	22°15′E and 23°E, 39°20′N and 39°45′N	NW-SE	60	15	Miocene (main rifting Pliocene)	k32, g4	Caputo (1990)
55	Karditsa	21°30′E and 22°30′E, 39°N and 39°45′N	NW-SE	90	30 (max)	Miocene (main rifting Pliocene)	k32, g4	Caputo (1990)
56	Illies rift cluster[14] 1. Freiburg-Bonndorf-Bodensee rift zone 2. Frauenstadt rift 3. Hohenzollern rift 4. Lauscher zone 5. Filder rift 6. Normal faults bounding Frankian Shield 7. Kissingen-Haßfurt rift zone 8. Heustreu-Haßberg zone	7°45′E and 11°E, 47°30′N and 50°15′N	NNE-SSW (cluster) WNW-ESE (individual rifts in cluster)	~280	110 (avg) 140 (Bonndorf-Bodensee rift line)	latest Oligocene–early Miocene[15] (pre-Burdigalian?)	k32, g4, k423, g4[16]	Carlé (1950), Illies (1981)

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[11] This chapter has a superb, nearly exhaustive, list of references to 1984, which however, is listed in full in the third volume of the book.

[12] This chapter has a superb, nearly exhaustive, list of references to 1983, which however, is listed in full in the third volume of the book.

[13] We prefer "Ergene" to avoid confusion with basins in western Thrace in Greece.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
57	Cheb basin	12°20′E and 12°30′E, 50°N and 50°15′N	NNW-SSE	21	10 (max)	Miocene (latest Oligocene?)	k423, g3 (g4?)	Svoboda et al. (1966, p. 516–522)
58	Valencia trough	0° and 4°E, 39°N and 41°20′N	NW-SE	350	120 (min) 160 (max)	late Oligocene–early Miocene	k411, g3	Cohen (1980), Watts et al. (1990), Banda and Santanach (1992), Foucher et al. (1992)
59	Sardinian west margin	7°E and 8°30′E, 38°30′N and 41°15′N	N-S	300	90 (avg)	middle to late Oligocene (Chattian)	k411, g3	Cohen (1980), Bigi et al. (1991)
60	Othoca[17]	8°30′E, 39°45′N and 41°N	N-S	135	20	middle Oligocene	k411, g3	Carmignani et al. (1989)
61	North Bohemian basin[18]	13°E and 14°E, 50°15′N and 50°40′N	ENE-WSW	70 (including volcanic Duppau Mountains)	10 (eastern ⅔) 23 (western ⅓)	middle Oligocene	k423, g3 (g4?)	Svoboda et al. (1966, p. 532–543; especially see Fig. XIII)
62	Hornsund fault zone	10°W and 13°W, 78°N and 79°N	NNW-SSE	400	60 (avg)	middle Oligocene	k31, g3	Steel et al. (1985)
63	Forlandsundet graben	11°E and 12°E, 76°30′N and 79°N	NNW-SSE	130?	20 (max)	middle Oligocene	k31, g3	Steel et al. (1985)
64	Bassin du Puy et Emblavès	3°50′E and 4°10′E, 44°50′N and 45°10′N	NW-SE	30	>10 (for each of the two basins)	Oligocene	k423, g4	Cogné et al. (1966), de Goër de Herve (1972), Bergerat (1987)
65	Bourgogne (also known as Bassin de Roanne)	4°E, 45°50′N and 46°30′N	NNW-SSE (strike of W boundary fault)	55	20 (avg)	Oligocene	k423, g4	Cogné et al. (1966), de Goër de Herve (1972), Bergerat (1987)
66	Forez	4°10′E, 45°30′N	NNW-SSE	50	20 (max) 15 (avg)	Oligocene	k423, g4	Cogné et al. (1966), de Goër de Herve (1972), Cogné and Slansky (1980), Bergerat (1987)
67	Limagne (Limagne sensu stricto)	3°20′ and 4°, 45°20′N and 47°N	N-S	160	30 (avg)	Oligocene	k423, g4	Cogné et al. (1966), de Goër de Herve (1972), Hirn and Perrier (1974), Cogné and Slansky (1980), Bergerat (1987)

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[14] Named after the great German master of extensional tectonics, J. Henning Illies (1924–1982), whose lifework contributed so significantly to (1) our understanding of the extensional structures in southwestern Germany, including the Upper Rhine rift and the rift cluster here under discussion, and (2) the rejuvenation of German earth sciences after World War II. The Illies rift cluster is a structure homologous to that formed by the Upemba, Usangu, Lake Mweru, Mweru Wantipa, Sumbu Chishi, and Muchinga Escarpment faults striking at right angles to the Tanganyika rift. Exactly as in the African case, the Illies group of rifts also reactivate old faults (in this case Saxonian).

[15] The age of these extensional structures is not well established. They cut the Upper Jurassic limestones and are unconformably overlain by the Upper Marine molasse, which is Burdigalian. The graben subsidences are so small (~100 m in the Freudenstadt, Hohenzollern, and Filder rifts: Carlé, 1950; Illies, 1982; 200 m in the Freiburg-Bonndorf-Bodensee rift: Carlé, 1950) as not to localize datable fills. Carlé (1950) attempted to reconstruct their evolution by taking out fault displacement in a stepwise fashion. The Filder rift zone, for example, Carlé found to have existed since the Lias. However, because subsidence amounts on these structures are so small, it is hard to distinguish graben subsidence from any other subsidence around them. That is why we take Illies's (1981) dating of the Hohenzollern rift (between the Upper Jurassic and the Burdigalian) as our starting point.

[16] It seems as if all of the extensional structures within the Illies rift cluster have originated as strike-slip faults. They are all very straight, and in the case of the Hohenzollern rift, the bounding normal faults seem to converge to a single steep fault below 1 km (cf. Illies, 1982, Fig. 3).

[17] This is the Roman name for the present-day town of Oristano located within the rift (Kiepert, undated, plate VII), which we use to designate what Carmignani et al. (1989) called the Sardinian graben. The reason why we do not follow their example is that the submarine basin to the east of Sardinia is also called the Sardinian basin (Bacino della Sardegna: Bigi et al., 1991, sheet 3; which is in fact a rift basin) and thus offers occasion for confusion. "Othoca rift" is a compact name and readily distinguishable from others around it.

[18] The North Bohemian basin (also known as the Egger rift), together with the Sokolov basin, make up the Ohre rift of the geologic literature of former Czechoslovakia (cf. Kopecky, 1979).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
68	Valréas-Mormoiron[19]	4°50′E, 43°50′N and 44°30′N	N-S	70	15 (avg)	Ludien (in S) Oligocene in general	k423, g4	Debrand-Passard et al. (1984), Debrand-Passard and Courbouleix (1984, Plate P5)
69	Apt-Forcalquier (Aix-en-Provence–la Bastide-Volonne)	5°E and 6°E, 43°20′N and 44°15′N	NNE-SSW	110	30–5	Oligocene	k411, g3, g4	Debrand-Passard et al. (1984), Debrand-Passard and Courbouleix (1984, Plate P5)
70	Vaccarès trough[19]	4°10′E and 5°E, 43°N and 43°30′N	NE-SW (general) NNE-SSW (NE and SW extremes) ENE-WSW (middle segment)	90	16 (max) 8 (avg)	Oligocene	k411, g3, g4	Debrand-Passard et al. (1984), Debrand-Passard and Courbouleix (1984, Plates P1 and P5)
71	Nîmes trough (with its prolongation in Gulf of Lion across a dogleg)	3°15′E and 4°30′E, 43°N and 44°N	NE-SW	130	15	middle Ludian (latest Oligocene? in Gulf of Lion)	k32, g4	Debrand-Passard et al. (1984, Figs. 8.19 and 8.45), Debrand-Passard and Courbouleix (1984, Plates P4 and P5), Rehault et al. (1985)
72	Lower Rhine rift (also known as Roer Valley rift)	4°E and 8°E, 50°N and 52°30′N	NW-SE	350	80 (max)	1. Permian–Triassic 2. late Eocene	1. k421, g1 2. k421, g1 or k31, g1	Illies (1974a, 1974b), Teichmüller (1974), Ziegler (1990), Zijerveld et al. (1992)
73	Bresse (also known as Saône trough)	4°30′E and 5°30′E, 44°30′N and 47°20′N	N-S	195	60 (max) 30 (avg)	Priabonian–Ludian	k32, g2 or k423, g4 (probably both)	Debrand-Passard et al. (1984, Figs. 8.19 and 8.45), Debrand-Passard and Courbouleix (1984, Plates P4 and P5), Bergerat (1987), Bergerat et al. (1990)
74	Drôme (also known as Bas-Dauphiné or Valence trough)[19]	4°50′E and 5°55′E, 44°45′N and 45°35′N	NNE-SSW	150	130 (max) 55 (avg)	Priabonian–Ludian	k32, g2 or k423, g4 (probably both)	Debrand-Passard et al. (1984, Figs. 8.19 and 8.45), Debrand-Passard and Courbouleix (1984, Plates P4 and P5), Bergerat (1987)
75	Sokolov basin	12°30′E and 13°E, 50°10′N and 50°20′N	ENE-WSW	30	10 (max) 7 (min)	latest Eocene	k423, g3 (g4?)	Svoboda et al. (1966, p. 522–532)
76	Eastern Languedoc	3°30′E and 4°30′E, 43°30′N and 44°30′N	NE-SW	200	70 (individual basin widths range from <10 to 20)	Lutetian (propagates north in Bartonian)	k32, g2 or k423, g4 (probably both)	Debrand-Passard et al. (1984, Fig. 8.33), Debrand-Passard and Courbouleix (1984, Plates P2–P4)
77	Kraichgau trough–Michelstadt graben–Gersprenz graben	9°E, 48°N	NNE-SSW	175	22 (max, in Gersprenz graben) 10 (min in Kraichgau trough)	Oligocene	k421, g1	Carlé (1950), Backhaus et al. (1974)

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[19] In the literature, the Vaccarès trough, the Valréas-Mormoiron basin, and the Drôme basin are frequently combined into a Rhone depression or a *coulouir rhodanien*. These basins became united only after the Aquitanian, and the unity was lost again by the Pliocene (Debrand-Passard and Courbouleix, 1984, plate N3). During the united history, the basin was part of a compressional molasse basin north of Vaucluse, and to the south, the waters of the opening Algero-Provençal basin invaded the formerly extended and subsided areas of southeastern France.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
78	Upper Rhine	7°15′E and 8°45′E, 47°30′N and 50°06′N	NNE-SSW	350	35	Lutetian	k421, g1 (type example!)[20]	Illies (1972, 1974a, 1974b, 1978), Illies and Greiner (1978), Şengör et al. (1978), Bergerat (1987), Brun et al. (1994), Şengör (1995)
79	Budejovice basin	14°20′E and 14°35′E, 48°50′N and 49°10′N	NW-SE	25	10 (avg)	late Coniacian, but mainly Santonian; renewed rifting Oligocene	Cretaceous: k421, g1? and/or k32, g1 Oligocene: k423, g3 (g4?)	Svoboda et al. (1966, p. 581–600)
80	Trebon basin	14°30′E and 15°E, 48°50′N and 49°15′N	NW-SE (Cretaceous) N-S (Oligocene)	70	21 (max)	late Coniacian, but mainly Santonian renewed rifting Oligocene	Cretaceous: k421, g1? and/or k32, g1 Oligocene: k423, g3 (g4?)	Svoboda et al. (1966, p. 581–600)
81	Hatton (also known as Hatton-Rockall basin)	14°W and 20°W, 57°30′N and 59°30′N	NE-SW	450	100 (max)	Late Cretaceous(?)–late Eocene	k1, g3	Roberts (1975)
82	Tromsø	17°'E and 20°E, 71°N and 72°N	NNE-SSW	110	30 (max)	Early to middle Cretaceous (inital faulting in Callovian?)	k1?, g3? k31, g1?	Ronnevik et al. (1975), Kelly (1988)
83	Røst	8°30′E and 12°30′E, 68°N and 69°N	NE-SW	170	90 (max) 50 (min)	Early Cretaceous (by analogy with Skomvær basin)	k1, g3	Eldholm and Talwani (1982), Mokhtari and Pegrum (1992)
84	Skomvær	11°45′E and 12°45′E, 67°30′N and 68°N	NE-SW	80	20	Early Cretaceous	k1, g3	Eldholm and Talwani (1982), Mokhtari and Pegrum (1992)
85	Rockall trough[21]	9°W and 20°W, 52°30′N and 59°30′N	NE-SW	900 (to Rosemary bank)	180[22]	Early Cretaceous	k1, g2	Roberts (1975), Bentley and Scrutton (1987), Megson (1987), Wood et al. (1987), Earle et al. (1989)
86	Soria	1°45′W and 3°45′W, 41°45′N and 42°30′N	E-W	>150	75 (max)	Late Jurassic–Early Cretaceous	k32, g1	Guiraud and Seguret (1985)
87	Lusitanian (including Bombarral and Arruda subbasins)	9°W and 9°30′W, 38°30′N and 40°N	NW-SE	160	40	late Oxfordian–Kimmeridgian	k1, g2	Wilson (1975, 1979), Ribeiro et al. (1979, p. 60–67)
88	Lower Saxony basin	7°30′E and 11°E, 52°15′N and 53°N	WNW-ESE	300	65	Late Jurassic	k32, g1	Betz et al. (1987), Ziegler (1990)
89	Horda-Egersund (southern part also known as Stord basin)	4°E, 57°30′N and 60°15′N	N-S	320	40 (max)	Early Triassic	k423?, g1	Fisher (1984), Ziegler (1990)

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[20] Later evolution complex! See Şengör (1995).

[21] Rockall trough has a narrow strip of oceanic crust within it (no wider than at most 60 km; Megson, 1987, Fig. 1). Magnetic anomalies exist, but remain unidentified (Cande et al., 1989). They must be older than or just coeval with anomaly 34 (Coniacian–Santonian). Spreading lasted for a very short time and was clearly inactive beyond anomaly 34 time. It is a basin that would have been similar to the Gulf of California had it had the latter's pronounced strike-slip component. We here deal only with its rifted margins facing the narrow oceanic strip plus the entirely continental northern half, and not with the oceanic strip itself.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
90	Weser depression	10°E and 11°E, 51°N and 53°30′N	NNE-SSW	240	40 (max)	Early Triassic	k32, g4	Betz et al. (1987), Ziegler (1990)
91	Glückstadt graben	9°E and 10°30′E, 53°N and 55°N	NE-SW N-S (N of Bremen)	200	50	Early Triassic	k32, g4 or, possibly, k33, g4	Betz et al. (1987), Ziegler (1990)
92	Emsland trough	7°E and 8°E, 52°30′N and 54°30′N	NNE-SSW NNW-SSE (side branches in N)	280	30 in S 90 (avg 20) in N	Early Triassic	k32, g4 or, more likely, k33, g4	Betz et al. (1987), Ziegler (1990)
93	Western Approaches basin (including Brittany trough and Southwest Channel basin)	3°W and 9°W, 48°N and 50°N	ENE-WNW	450	130 (max, in W) 50 (min in E)	Early Triassic (sedimentation started in Late Carbonaceous, probably in a compressional setting)	k423, g4	Avedik (1975), Ziegler (1990)
94	Haig-Fras depression	6°W and 8°30′W, 48°45′ and 50°45′N	ENE-WSW	215	30	Early Triassic	k423, g4	Ziegler (1990)
95	South Celtic Sea basin (including Bristol Channel basin)	3°W and 9°W, 50°N and 51°20′N	ENE-WSW (W half) E-W (E half)	440	50 (avg)	Early Triassic	k423, g4	Coward and Trudgill (1989), Ziegler (1990)
96	Kish Bank	3°30′W, 53°10′N	N-S (general)	60	80	Early Triassic	k32, g4, k423, g4	Ziegler (1990)
97	North Celtic Sea basin (including Caernarvon basin)[23]	4°W and 10°W, 50°N and 52°N	ENE-WSW	600 110 in W (per Ziegler) 100 in E 50 in W (per Coward and Trudgill)	50 in E	Early Triassic[24]	k423, g4	Ainsworth et al. (1987), Millson (1987), Coward and Trudgill (1989; they included Caernarvon basin in width estimate), Ziegler (1990); see also Day et al. (1989, p. 430) for timing of inception of faulting
98	Varanger	30°E and 35°E, 70°45′N and 71°45′N	WNW-ESE	200	80	Triassic	k423, g1?	Dowdeswell (1988), Haefford and Kelly (1988), Kelly (1988)
99	East Irish Sea basin[25]	3°12′W and 4°30′E, 52°40′N and 54°30N	N-S	210	70	Early Permian	k422, g4 or k423, g4	Colter and Barr (1975), Glennie (1984a), Jackson et al. (1987), Ziegler (1990, especially Fig. 38)

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[22] At latitude of Anton Dohrn Seamount, where no oceanic crust is present.

[23] East-northeast–striking normal faults bounding the Caernarvon basin to the south separate the Anglesey Peninsula from the mainland and provide a connection with the Manx-Furnesse basin (see Fig. 38 in Ziegler, 1990).

[24] There was normal-fault–controlled sedimentation in Somerset, Devon, Wiltshire, and Dorset in the Permian along such faults as the Vale of Pewsey and the Vale of Wardour (Mere; cf. Holloway, 1985b, especially Fig. 4.3), i.e., along the strike of the Bristol Channel basin. These faults belong to another basin, though, the Wessex-Channel basin, and Day et al. (1989) claimed that such faulting did not extend westward in the Permian.

[25] In some places only called the "Irish Sea basin"; includes the following subbasins: Tynwald, Lagman, Eubonia, Keys, Godred Croven, East Deemster, Northeast Deemster, West Deemster, Cheshire, Manx-Furness.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
100	Sub-Paris rift	2°E, 49°30′N	NNW-SSE	100	25	Early Permian	k423, g1 or k32, g1	Ziegler (1990)
101	Moray Firth basin (consisting of Inner Moray Firth, Dutch Bank, Witch Ground, and Buchan troughs)	4°W and 1°E, 57°30′N and 59°N	E-W	310	150	Early Permian[26]	k32, g1 and k423, g1; k1, g2 for Late Jurassic	Barr (1985), Harker et al. (1987), Boote and Gustav (1987), Duindam and van Hoorn (1987), Ziegler (1990, 1992), Underhill (1991)
102	Viking graben	1°E and 4°E, 58°N and 62°N	NNE-SSW	600	70 in S 180 in N (including the Møre basin)	Late? Permian	k 421, g1 or k423 g1 (we prefer the k421 interpretation)	Şengör (1976), Hay (1978), Glennie (1984a), Nelson and Lamy (1987), Klemperer (1988), Ziegler (1990, 1992)
103	Wessex-Channel basin (including Weald basin, Pewsey basin, Dorset basin, Channel basin)	3°W and 2°E, 50°15N and 51°15N	E-W to ESE-WNW	350	100 (max)	Permian[27]	k423, g4	Holloway (1985a), Penn et al. (1987), McLimans and Videtich (1987), Dranfield et al. (1987), Ziegler (1990)
104	Lough Neagh–Arran	4°30′W and 7°W, 54°30′N and 56°N	NE-SW	200	50	Permian	k423, g4	Whitbread (1975)
105	Lough Foyle–Islay	5°30′W and 7°W, 54°45′N and 55°45′N	NE-SW	130	30	Permian	k423, g4	Whitbread (1975)
106	Central graben (consisting of Forties and Ecofisk troughs)	1°E and 6°E, 54°N and 57°45′N	NNW-SSE	450	120 (max) 30 (min)	Late Carboniferous–Permian in S; propagated N by Late Permian; rejuvenated by Late Jurassic plume activity	k 421, g1 or k423 g1 (we prefer the k21 interpretation); k1, g2 for Jurassic	Whiteman et al. (1975), Şengör (1976), Barton and Wood (1984), Holliger and Klemperer (1990), Ziegler (1992), Underhill and Partington (1993)
107	West Netherlands–Broad Fourteens–Sole Pit	0° 5°30′E, 49°30′N and 55°N	NNW-SSE	600	120 (max)	Late Carboniferous–Permian	k 421, g1 or k423 g1 (we prefer the k21 interpretation)	Walker and Cooper (1987), Holliger and Klemperer (1990), Ziegler (1990, 1992)
108	Horn	6°30′E and 8°E, 54°30′N and 56°45′N	N-S to NNE-SSW	225	35	Late Carboniferous–Permian	k421?, g1 or k422, g1	Glennie (1984b), Cartwright (1990), Vejbæk (1990), Ziegler (1990, 1992)
109	Oslo rift (including Skagerrak rift or Bamble trough)	8°E and 11°E, 58°N and 61°N	NNE-WSW	400	35	Late Carboniferous–Permian	k421?, g1 or k422, g1	Ramberg (1976), Ro et al.(1990a, 1990b), Neumann et al. (1992), Ro and Faleide (1992)
110	Worcester basin	2°W, 51°30′N and 52°45′N	N-S	180	30	latest Carboniferous–Permian	k421?, g1 or k422, g1	Hains and Horton (1969), Holloway (1985b), Ziegler (1990)

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[26] Some think it is Jurassic on account of thin Permian–Triassic section. See, for example, Barr (1985). Dutch bank is Devonian; strong rejuvenation in Late Jurassic was due to plume.

[27] Penn et al. (1987) reported that rifting occurred in the Permian on the basis of the 500-m-thick Permian clastic section in the Channel (or East Channel) basin. But Dranfield et al. (1987) showed that the Permian section is *not* fault bounded and that *normal* faulting occurred in the Early Triassic, as in many east-northeast–, east-, or east-southeast–trending basins of northwestern Europe, as depicted in Ziegler's atlas (1990). Holloway (1985a, 1985b) had previously showed normal faulting in the Pewsey basin to have started in the Permian. We therefore place the onset of the Wessex-Channel basin complex in the Permian.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
111	Hessian depression[28]	8°30′E and 10°E, 51°30′N and 52°N	N-S (general) NNW and NE (strike of dominant brittle elements)	120	55 at N end <20 at S end	1. latest Carboniferous 2. Triassic 3. Late Jurassic 4. latest Eocene–Oligocene	k423, g4	Knetsch (1963, p. 333–340), Schenk (1974), Meiburg (1982)
112	Porcupine trough	11°30′W and 14°W, 50°N and 53°N	N-S (with a tendency to NNE strike at N end)	360	180 in S 50 in N	Stephanian	k422, g1 or k421, g1 or k33, g1 (our preference is k421[29])	MacDonald et al. (1987), Croker and Shannon (1987), Croker and Klemperer (1989), Ziegler (1990)
113	Harstad	8°E and 10°E, 69°N and 71°N	NNE-SSW	220	>25	Late? Carboniferous (pre–Middle Jurassic, in any case)	k31, g3 or k32, g3; in Jurassic k1, g3	Ronnevik et al. (1975)
114	Vøring	1°30′E and 8°30′W, 64°30′N and 67°30′N	NE-SW	240	210	Late Carboniferous; but main subsidence seems post–Late Jurassic	k32?, g3?	Talwani et al. (1981), Eldholm and Talwani (1982), Ziegler (1988)
115	Vestfjord	8°W and 15°W, 66°30′N and 68°N	NE-SW	200	50	Late Carboniferous	k32?, g3?	Eldholm and Talwani (1982), Haszeldine (1984, especially Fig. 5), Ziegler (1988)
116	Nordkapp	26°E and 37°E, 55°N and 56°N	NE-SW	450	80	Early Carboniferous	k31, g1 or g3?	Dowdeswell (1988); Heafford and Kelly (1988), Kelly (1988)
117	Solway-Northumberland basin[30]	2°W and 5°W, 55°N and 56°N	ENE-WSW NNW-SSE (Carlisle–Vale of Eden basins)	220 70 (Carlisle–Vale of Eden basins)	20 (min) 40 (max) 9–15 (Carlisle–Vale of Eden basins)	Early Carboniferous Permian (Carlisle–Vale of Eden basins)	k31, g1 or g3? Carlisle–Vale of Eden basins: k423, g1	Taylor et al. (1971), Johnson (1984), Holloway (1985b), Ord et al. (1988), Ziegler (1990)
118	West Shetland–Faeroe	1°30′W and 6°W, 60°N and 62°30′N	NW-SE	220	60	latest Devonian Late Jurassic (main rifting)	Devonian: k31, g1; Jurassic: k21, g1 (g3?)	Hitchen and Ritchie (1987), Duindam and van Hoorn (1987), Hitchen and Richie (1987), Maedows et al. (1987), Mudge and Rashid (1987), Earle et al. (1989)

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[28] Taphrogenically, the Hessian depression is an extremely complex and bewildering structure. It is co-extensive with the Solling block, which is cut by numerous "grabens" whose widths are no more than a few kilometers, yet they are tens of kilometers long. Many display evidence of shortening across the axis; some, alternating episodes of extension and shortening. Movements on these peculiar structures started in the Late Jurassic and still have not entirely ceased. Historically, this is the area that misled the great German student of tectonics Hans Stille (1876–1966) into thinking that all tectonic structures are due to compression. All this complexity is mostly a result of thick Zechstein salt underlying the Mesozoic and Cenozoic section, giving it a partial structural autonomy with respect to the basement. The narrowness of grabens, for example, reflect the fact that they disrupt only the section above the Zechstein, whereas below that detachment horizon, the strain is accommodated otherwise. There is also much strike-slip faulting (see Şengör, 1995, Fig. 2.10).

[29] This interpretation makes the Appalachians a transpressional orogen and thus accounts for their linearity compared with both the Hercynides and the Ouachita-Marathon-Huastecan systems and for the absence of impactogens despite the presence of Appalachian salients and recesses.

[30] We follow Ord et al. (1988) in considering the Solway and Northumberland basins as one, not the least owing to the transtensional component. In the Permian, the Solway basin connected with the Carlisle and the Vale of Eden basins.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Western Europe and the Balkans *(continued)*								
119	Helgeland	3°W and 11°W, 63°N and 67°N	NE-SW	440	130	Early Devonian (see Ziegler, Plate 2)	k31?, g1? or k32?, g4?	Eldholm and Talwani (1982), Ziegler (1988)
120	Solund	5°E	E-W	35	38 (max)	Early? Devonian	k32, g4	Steel (1976), Steel and Gloppen (1980)
121	Kvamshesten(?)	5°E	E-W	22	5 (max)	Early? Devonian	k32, g4	Steel (1976), Steel and Gloppen (1980)
122	Håstainen(?)	5°E	E-W	12	5 (max)	Early? Devonian	k32, g4	Steel (1976), Steel and Gloppen (1980)
123	Hornelen	5°E, 61°50′N	E-W	65	20 (avg)	Early? Devonian	k32, g4	Steel (1976), Steel and Gloppen (1980)
124	Møre basin	1°30′W and 6°30′W, 62°N and 64°N	NNE-SSW	400	100 (avg)	Devonan? Jurassic–Cretaceous (main stretching)	k31?, g3? k 421, g3? (if rifting is proved to be Permian)	Talwani and Eldholm (1977, Fig. 19), Haszeldine (1984), Nelson and Lamy (1987)
125	West Hebrides platform basins (six small, one-sided rift basins)	7°W and 8°30′W, 56°30′N and 59°N	NNE-WSW	70 (max) 20 (min)	20 (max) 5 (min)	Devonian (earliest Permian per Ziegler)	k31?, g3?	Haszeldine (1984), Ziegler (1990)
126	Malin Sea basin	6°W and 10°W, 55°N and 57°30′N	NE-SW	320	60	Devonian	k31?, g3?	Haszeldine (1984), Duindam and van Hoorn (1987)
127	Minches basins	6°W and 8°W, 56°30′N and 58°N	NE-SW	130	60	Devonian	k31?, g3?	Duindam and van Hoorn (1987), Ziegler (1990)
128	Western Orkney[31] basins	1°30′W and 4°30′W, 58°N and 59°30′N	NE-SW	180 (aggregate)	80 (aggregate)	Devonian (red-bed sedimentation in Early Permian per Ziegler)	k31?, g3?	Haszeldine (1984), Coward and Enfield (1987), Duindam and van Hoorn (1987), Enfield and Coward (1987), Ziegler (1990)
129	Orcadian basin[32]	3°30′W and 6°30′W, 58°45′N and 60°N	NE-SW	160	30	Devonian (sedimentation started in Permian per Ziegler)	k31?, g3?	Duindam and van Hoorn (1987), Ziegler (1990)
130	Midland Valley (including Ulster basin)	10°30′W and 0°, 54°N and 58°N	ENE-WSW	800	100 in Scotland 60 in Ireland	latest Silurian–Early Devonian (Ulster sedimentation began in Permian)	k31? g3?	Anderton et al. (1979), Collective of Authors (1984), Glennie (1984b)
Eurasia—Asia and Eastern Europe								
1	Tibetan taphrogen[33]	80°E and 90°E, 28°N and 34°N	N-S (fault trend) E-W (long axis of taphrogen)	1100	950	Pliocene–Pleistocene	k22, g4	Han et al. (1984), Mercier et al. (1984, 1987, 1991), Rothery and Drury (1984), Armijo et al. (1986), Dewey et al. (1988), Molnar (1992), Yin (2000)
2	Jangngai Ri[34]	87°E, 33°N	N-S (fault trend; overall shape is equant)	40	65	Pliocene–Pleistocene	k22, g4	Rothery and Drury (1984), Armijo et al. (1986), Mercier et al. (1991), Molnar (1992)

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[31] Part of the Minch or Minches basin in some publications. Duindam and van Hoorn (1987) used both names for what is here called the Western Orkney basins in the same paper!

[32] Ziegler (1990)showed this basin only in part.

[33] The Tibetan taphrogen does not include the extensive normal faults running parallel with the trend of the Himalayan Chain and representing essentially gravity-collapse structures of the gigantic mountains. All of the extension they represent is accommodated within the shallow to mid-crust. The structures they bound are commonly metamorphic core complexes that superficially resemble the western North American ones. Because they do not penetrate the lithosphere they are not considered rifts.

[34] Double rift.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
3	Thakkola	83°50E and 84°10E, 30°N and 31°N	N-S	100	20	Pliocene–Pleistocene	k22, g1	Rothery and Drury (1984), Armijo et al. (1986), Mercier et al. (1991), Molnar (1992)
4	Garyarsa-Moinjer	80°E and 81°E, 31°30′N and 33°N	NW-SE	200	20–15	Pliocene–Pleistocene	k32, g3	Rothery and Drury (1984), Armijo et al. (1986), Mercier et al. (1991), Molnar (1992)
5	Yagra	82°30′E, 30°45′N and 32°20′N	N-S	170	20 (max)	Pliocene–Pleistocene	k22, g1	Rothery and Drury (1984), Armijo et al. (1986), Mercier et al. (1991), Molnar (1992)
6	Lunggar Shan–Ringtor–Bünsum rift chain[35]	83°E and 84°E, 30°N and 32°N	N-S (sinuous)	200	30 (max)	Pliocene–Pleistocene	k22, g3	Rothery and Drury (1984), Armijo et al. (1986), Mercier et al. (1991), Molnar (1992)
7	Bangkor–Cazê–Kung Co rift chain	86°E and 87°E, 28°N and 32°N	N-S	400	20 (max)	Pliocene–Pleistocene	k22, g3	Rothery and Drury (1984), Armijo et al. (1986), Mercier et al. (1987, 1991), Molnar (1992)
8	Xainza-Dinggye rift chain	88°E and 88°30′E, 27°30′N and 30°45′N	NNE-SSW	380 (discontinuous)	15 (avg)	Pliocene–Pleistocene	k22, g3	Rothery and Drury (1984), Armijo et al. (1986), Mercier et al. (1987, 1991), Molnar (1992)
9	Yadong-Gulu rift chain	89°E and 90°30′E, 27°N and 30°N	NNE-SSW	400	30 (max)	Pliocene–Pleistocene	k22, g3	Rothery and Drury (1984), Armijo et al. (1986), Mercier et al. (1987, 1991), Molnar (1992)
10	Shanxi (Fenwei) rift	107°E and 115°E, 34°N and 40°N	70°–25°	960	90	Pliocene–Quaternary	d2-k3-k32-g3	Xu Xiwei and Ma Xingyuan (1992), Yang Weiran et al. (1996)
11	Central Okhotsk basin	147°E and 151°E, 54°N and 56°N	305°	180	120	Pliocene	d1-k2-k22	Gnibidenko (1976), Baboshina et al. (1984), Gnibidenko and Khvedchuk (1982)
12	Lake Hazar	38°40′E, 39°20′N	ENE-WSW	10	2.5	Pliocene	k32, g1	Hempton et al. (1983), Dunne and Hempton (1984)
13	Simav	28°15′E and 29°15′E, 38°45′N and 39°10′N	ESE-WNW	100	<10	Pliocene	k411, g4S k422, g4	Şengör et al. (1985), Yılmaz et al. (2000)
14	Edremit[36]	26°E and 27°30′E, 38°45′N and 39°15′N	ENE-WSW	130	30	Pliocene	k411, g4S k422, g4	Şengör et al. (1985), Karacik and Yılmaz (1998), Yılmaz et al. (2000)
15	Küçük Menderes (Caÿstrius)	27°15′E and 28°30′E, 38°N	E-W	100	15 (avg)	Pliocene	k411, g4S k422, g4	Şengör et al. (1985)
16	Karlıova	41°15E, 39°N	E-W (long axis; rhomboidal)	9	6 (max)	Pliocene	k5, g1	Şengör (1979), Şengör et al. (1985)
17	Hula-Kinneret rift	35°30′E, 32°20′N and 33°10′N	N-S	110	20	Pliocene	k32, g1	Manspeizer (1985)
18	Dead Sea rift	35°30′E, 31°N and 31°50′N	N-S	100	25	Pliocene	k32, g1	Quennell (1958), Manspeizer (1985), Ben-Avraham (1987), Chaimov et al. (1990)
19	Elat rift	35°E, 28°N and 29°30′N	NNE-SSW	150	25	Pliocene	k32, g1	Manspeizer (1985), Livnat et al. (1987),
20	Gökova (also known as Kerme)	27°E and 28°30′E, 36°45′N and 37°N	E-W	120	25 (narrows eastward)	late Pliocene	k411, g4S k422, g4	Şengör et al. (1985), Görür et al. (1995)
21	Bakırçay (consisting of Bergama, Zeytindağ, and Değirmendere rifts)	27°E and 28°15′E, 38°45′N and 39°15′N	ENE-WSW	75	15	latest Miocene, early Pliocene	k411, g4S k422, g4	Şengör et al. (1985), Yılmaz et al. (2000)
22	Havza-Lâdik-Taflova-Erbaa	36°E and 38°E, 40°40′N	NNW-SSE	150	5	late Miocene–Pliocene[37]	k32, g3	Şengör et al. (1985), Bellier et al. (1997), Över et al. (1997)
23	Erzincan	27°15′E and 29°E, 39°20′N	NNW-SSE	50	20	late Miocene–Pliocene	k32, g1	Akkan (1964), Şengör et al. (1985)

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[35] This is a double rift, forming a mini–rift cluster of only two parallel chains.

[36] Not including Evciler and Bayramiç half grabens and the Gülpınar cross-graben; see Yılmaz et al. (2000, Fig. 7).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
24	Hatay-Adana	35°E and 37°E, 35°30′N and 36°45′N	NE-SW (longest axis [Hatay-Kahramanmaras]; triangular)	250	>100 (between Hatay and Adana)	Post middle Miocene	k5, g1	Şengör et al. (1985), Perinçek and Eren (1990), Polat et al. (1997)
25	Alaşehir (also known as Gediz)	27°E and 29°E, 38°N and 38°20′N	E-W (in W) ESE-WNW (in E)	200	20 (avg)	late Miocene (Tortonian?)	k411, g4S k422, g4	Şengör (1982, 1987), Şengör et al. (1985), Hetzel et al. (1995a, 1995b), Yilmaz et al. (2000)[38]
26	Büyük Menderes (Meander, not including cross-grabens to S; see Şengör, 1987)	27°15′E and 29°E, 37°30′N and 37°50′N	E-W NE-SW (in extreme W)	200	<20	late Miocene (Tortonian?)	k411, g4S k422, g4	Şengör (1982, 1987), Şengör et al. (1985), Hetzel et al. (1995a)[39]
27	Akçakale	35°E and 36°30′E, 35°30′N and 36°45′N	N-S	120	20 (avg)	late Miocene	k412, g1 (definitely k42, could be k422	Şengör et al. (1985), Tardu et al. (1987)
28	Suruç	38°30′E, 37°N	NNW-SSE	30	20	late Miocene	k412, g1 (definitely k42, could be k422	Tardu et al. (1987)
28a	Central Lowlands of Burma	95°E and 97°E, 15°N and 25°N	N-S	1000	250	early to late Miocene	k411, g1, k31	Burri and Huber (1932), Krishnan (1949), Office of the Technical Cooperation of the United Nations (1978), Bannert and Helmcke (1981), Bender (1983)
29	Kerala-Lakshadweep	74°30′E and 77°E, 8°30′N and 12°30′N	NNW-SSE	400	~100	middle Eocene	k421, g3?	Naini and Talwani (1982), Sahni (1982), Raha and Rajendran (1984), Subrahmanian and Muraleedhavan (1985)
30	Ragay Samar	122°E and 125°20′E, 12°N and 15°N	310°	450	100	early to middle Miocene	k32, g1	Hutchison (1989, p. 96)
31	South Mindoro	122°E, 11°N and 14°30′N	N-S	250	60	Oligocene?–early Miocene	k411, g1	Hutchison (1989, p. 95–97)
32	Luzon central valley	121°E and 121°30′E, 14°30′N and 17°N	335	500	50	Oligocene?–early Miocene	k411, g1 k32, g1	Hutchison (1989, p. 95–97)
33	Evoron-Chukchagir	135°E and 138°E, 50°N and 56°N	20°	250	20–40	Oligocene–Miocene	d2-k3-k32-g4	Kozlovsky (1988)

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[37] The age of the basins along the North Anatolian fault has been revised by Över et al. (1997) from late Miocene to Pliocene. This revision is based on the finding of a new, as yet unnamed ostracod species of the genus *Virgotocypris*. On the island of Kos, this species seems confined to the Pliocene–Quaternary (Mostafawi, 1990). Över et al. used charophyte species and this ostracod to bracket the age of the Lower Pontus Formation, the lowest unit of the North Anatolian fault–related basins, within the Pliocene. As the details of Över et al.'s sampling are not published, we are unable to judge the accuracy of the bracketing. However, the unreliability of terrestrial ostracod ages at long distances have led us to report Över et al.'s stratigraphic interpretation with caution and not to revise the ages of the basins we cite accordingly until we learn the details of their sampling and the thorough reporting of the new species.

[38] This paper in particular gives a useful list of references to the most up-to-date literature including the recent debate on the age of the rifts. A regrettable oversight is Şengör (1987), which really forms the basis of much of the debate and presents the interpretation adopted by Yılmaz et al. (2000).

[39] The basic conclusion of this paper is nothing more than a repetition of that of Şengör (1987)—though the authors seem not to be aware of it—except that it contains isotopic age data bringing the onset of extension possibly down to 20 Ma. There is now increasing evidence that a N-S extension of late Oligocene–early Miocene age did affect the Menderes massif (e.g., Bozkurt and Park, 1994; Hetzel et al., 1995b), but neither its relationship to the later N-S extension, which is still going on, nor its cause is clear. Yilmaz et al. (2000) presented evidence that they interpreted to indicate N-S shortening until the late Miocene in western Turkey, which further complicates the issue.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
34	Kukhtuy basin	143° and 144°E, 59° and 60°N	335°	125	50	Miocene	d2-k3-k32	Drabkin (1970)
35	North Okhotsk basin	143° and 152°E, 57°N and 59°N	90°	470	70–120	late Oligocene–Miocene	d2-k4-k42	Andreyev and Krasny (1983), Baboshina et al. (1984), Zhuravleyev (1984), Worrall et al. (1996)
36	Red Sea Arabian margin	34°E and 44°E, 13°30′N and 28°N	NNW-SSE	1800	70 (max)	latest Oligocene[40]–Miocene	k1, g2	Bowen and Jux (1987), Crossley et al. (1992), Hughes and Beydoun (1992), Mitchell et al. (1992), Coleman (1993), Montenat et al. (1986, 1998a, 1998b), Rihm and Henke (1998), Şengör (this volume)
37	Gulf of Aden Arabian margin	43°E and 60°E, 13°N and 22°N	ENE-WSW	1700	250 (max)	early Oligocene to Miocene	k1, g2[41]	Beydoun (1970), Cochran (1981, 1982), Hughes and Beydoun (1992), Bott et al. (1992), Fantozzi and Sgavetti (1998), Watchorn et al. (1998)
38	Madura (passes sideways into oceanic Bali and Flores basins)	111°E and 115°E, 6°40′S and 8°S	E-W	470	100	Neogene	k411, g1	Hamilton (1979)
39	Bone basin	120°30′E and 121°30′E, 2°30′S and 4°30′S	N-S to NNW-SSE	250	80 (avg)	Neogene	k411, g1	Hamilton (1979), Silver et al. (1981)
40	Outer basinal area	108°30′E and 110°20′E, 3°30′N and 7°N	NNW-SSE	300	50	Neogene (older?)	k32, g1	Hutchison (1989)
41	Baykal rift zone	100°E and 120°E, 51°N and 57°N	0°–35°	1500	200	Oligocene	d2-k3-k31-g4	Zonenshain and Savostin (1981), Kozlovsky (1988), Logachev and Zorin (1992), Sherman (1992), Yang Weiran et al. (1996), Mishenkin et al. (1999), Petit et al. (1998)
41a	Busingol	97°E and 98°E, 50°30′N and 51°30′N	10°	90	15	Oligocene	d2-k3-k31-g1	Logachev and Zorin (1992)
41b	Hubsugul graben	99°E and 100°E, 50°N and 52°N	0°	120	20–30	Oligocene	d2-k3-k31-g1	Logachev and Zorin (1992)
41c	Tunka graben	101°E and 103°E, 51°N and 52°N	90°	90	15–30	Oligocene	d2-k3-k31-g1	Kozlovsky (1988), Logachev and Zorin (1992), Sherman (1992)
41d	Lake Baykal	104°E and 110°E, 52°N and 56°N	55°-20°	650	50–75	Oligocene	d2-k3-k31-g3	Kozlovsky (1988), Logachev and Zorin (1992), Sherman (1992)
41e	Upper Angara graben	100°E and 113°E, 56°N and 57°N	55°	127	35	Oligocene	d2-k3-k31-g1	Logachev and Zorin (1992), Sherman (1992)
41f	Barguzin graben	100°E and 101°E, 53° and 55°N	35°	187	15–30	Oligocene	d2-k3-k31-g1	Kozlovsky (1988), Logachev and Zorin (1992), Sherman (1992)
41g	Muya graben	114°E and 116°E, 57°N	90°	110	50	Oligocene	d2-k3-k31-g1	Logachev and Zorin (1992), Sherman (1992)

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[40] If the Lower Rudeis Formation along the coast of the Ethiopian Red Sea does extend down into the top of the Oligocene (cf. Hughes and Beydoun, 1992).

[41] This interpretation does not take into account the rifting component added to the uplift-doming-rifting interpretation (i.e., k1, g2) generated by the westward propagation of the Carlsberg Ridge. We think it was a major influence on the rifting of the Afar dome (see Şengör, this volume).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
41h	Chara graben	117°E and 120°E, 57°N and 58°N	55°	110	15–35	Oligocene	d2-k3-k31-g1	Kozlovsky (1988), Logachev and Zorin (1992), Sherman (1992)
42	Makassar Strait, east margin	120°30′E and 121°30′E, 1°N and 5°S	N-S to NNE-SSW	600	200 (max)	Oligocene to Neogene	k411, g1	Hamilton (1979)
43	Hainan Shelf (South China Shelf)	107°E and 120°40′E, 18°N and 25°N	ENE-WSW	1100	500	middle Oligocene?	k33, g4	Hutchison (1989), Rangin et al. (1995a, 1995b), Taylor and Hayes (1983)
44	Sokong	108°45′E and 110°15′E, 2°N and 4°30′N	NNW-SSE	200	50 (max)	Oligocene	k411?, g1 (Hutchison), k32, g1	Hutchison (1989)
45	Penyu-Natuna basin	104°E and 108°40′E, 3°10′N and 7°30′N	ENE-WSW	600	220	Oligocene (older?)	k32, g1	Hutchison (1989, p. 179)
46	Malaya basin (also known as Malay basin)	102°E and 104°40′E, 6°N and 8°N	NW-SE	400	150	Oligocene (older?)	k32, g1	Hutchison (1989, p. 90–92)
47	Gulf of Thailand (including Pattani trough and Western and Kra basins)	100°E and 103°45′E, 7°N and 12°N	N-S to NNW-SSE	700	180 (max)	Oligocene (older?)	k32, g4	Dahm and Graebner (1982), Khantaprab and Sarapirome (1983), Hutchison (1989, p. 92)
48	Saigon	109°E, 9°N	NE-SW	300	100	Eocene (Oligocene?)	k32, g1	Hutchison (1989), Rangin et al. (1995b)
49	Gizhiga basin	160°E and 164°E, 61°N and 63°N	55°	250	50–85	Eocene	d2-k4-k42	Drabkin (1970)
50	Yama basin	151°E and 155°E, 59°N and 60°N	90°	200	25–75	Eocene	d2-k4-k42	Drabkin (1970)
51	Tauy basin	145°E and 150°E, 59°N and 60°N	90°	250	50–125	Eocene	d2-k4-k42	Drabkin (1970)
52	Belkov-Svyatoi Nos rift	142°E and 132°E, 73°N and 76°N	330°	500	30–70	late Eocene[42]	d1-k1-g3	Bogdanov and Khain (1998), Drachev et al. (1998), Ivanov et al. (1998)
53	Northern Sumatra basin (merging with Mergui Terrace in N)	96°E and 98°E, 4°N and 9°N	NW-SE	500	200	Eocene	k32, g1	Koesoe-madinata (1978), Hutchison (1989, p. 73–76)
54	Central Sumatra basin	98°E and 110°E, 0°30′N and 4°N	NW-SE	400	150	Eocene	k32, g1	Koesoe-Madinata (1978), Lowell (1980), Hutchison (1989, p. 73–76)
55	Vung Tau	105°30′E and 109°E, 9°N and 11°N	E-W	200	50	Eocene	k32, g1	Hutchison (1989, p. 92–93)
56	Tarakan	116°E and 120°E, 4°N and 6°N	NE-SW	300	100	Eocene	k32, g1	Hutchison (1989, p. 79–80)
57	Kutei	115°E and 117°30′E, 0° and 1°N	E-W	260	50 (max)	Paleocene	k411, g4	Hutchison (1989, p. 78–79)
58	Parecel Islands–Macklefields rift cluster	110°E and 115°E, 13°N and 18°N	E-W (individual rift trends) N-S (long axis of cluster)	600	600 (individual rifts <50	Paleogene	k33, g4	Rangin (1995b)

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[42] Compression during the Oligocene to middle Miocene (Drachev et al., 1998).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
59	Cambay (also known as Sabarmati)	72°E and 74°E, 20°N and 27°N	NNW-SSE	250	50	late Paleocene–early Eocene with Early Cretaceous ancestry?	k1?, g2	Valdiya (1973), Rao and Talukdar (1980), Sahni (1982), Biswas and Deshpande (1983), Raju and Srinivasan (1983), Raju and Hardas (1985), Sastry et al. (1984), Chowdhury et al. (1989)
60	Bohai basin	114°E and 124°E, 35°N and 42°N	30°–80°–50°	1250	450	Paleocene–early Eocene and middle Eocene	d2-k3-k31-g4 and d2-k3-k32-g4	Sheldok et al. (1985), Ye Hong et al. (1985), Xu Guizhong (1986), Allen et al. (1997), Li Desheng (1991), Tian Zai-Yi et al. (1992), Zhao-Junmeng and Lu-Zaoxun (1998), Liu Delai and Ma Li (1998)
61	South Yellow Sea basin	118°E and 125°E, 33°N and 37°N	50°	660	240	Paleocene–Eocene	d2-k4-k41-k411-g3 or d2-k3-k32-g4	Li Desheng (1984, 1991)
62	East China Sea basin	118°E and 128°E, 24°N and 34°N	40°	1470	80–270	Paleocene–Eocene[43]	d2-k4-k41-k411-g3	Li Desheng (1984, 1991)
63	Pearl River mouth basin	107°E and 118, 27°N and 22°N	75°	980	330	Paleocene–Eocene[44]	d2-k4-k41-k411-g3	Daquan et al. (1989), Li Desheng (1984, 1991)
64	Bombay offshore	70°E and 73°E, 17°N and 21°N	NNW-SSE	550	160–280	Late Cretaceous–Paleocene	k1?, g2	Rao and Talukdar (1980), Naini and Talwani (1982), Mitra et al. (1983)
65	Moma rift zone	147°E and 131°E, 63°N and 72°N	305°–345°	1250	40–250	latest Cretaceous–Holocene[45]	d1-k1	Grachev (1982), Zonenshain et al. (1990)
65a	Omoloysk graben	135°E and 131°E, 72°N and 76°N	345°	240	40	Late Cretaceous to Cenozoic	d1-k1	Fujita and Cook (1990), Drachev et al. (1998), Sekretov (1998a)
65b	Moma rift cluster	147°E and 133°E, 63°N and 72°N	305°–330°	1000	50–250	Oligocene–Holocene[46]	d1-k1	Grachev (1982), Zonenshain et al. (1990)
66	Ust-Lena rift	129°E and 120°E, 73°N and 74°N	315°	500	100–300	Late Cretaceous–Cenozoic[47]	d1-k1	Bogdanov and Khain (1998), Drachev et al. (1998), Hinz et al. (1998),[48] Ivanov et al. (1998), Sekretov (1998a)
67	North Chukchi basin	170°W and 150°E, 74°N and 79°N	285°–315°	1300	250–300	latest Cretaceous–Paleogene[49]	d1-k2-k22-g3	Grantz and May (1982), Grantz et al. (1990), Haimila et al. (1990), Sekretov (1998b),[50] Shipelkevich et al. (1998)

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[43] Pre-Miocene folding is reported.

[44] Pre-Miocene folding is reported.

[45] The Moma rift zone is considered to be a propagated continuation of the Gakkel spreading center in the Arctic Ocean to the southeast (Grachev, 1983; Rowley and Lottes, 1988; Zonenshain et al., 1990). Recent studies have shown that extension related to the Gakkel Ridge terminated at its junction with the Eurasian continental margin (Bogdanov and Khain, 1998; Drachev et al., 1998; Sekretov, 1998a) and did not propagate farther to the southeast since the Oligocene (Roeser et al., 1998). Anomaly 24 (Zonenshain et al., 1990; 56 Ma, the Paleocene-Eocene boundary) is the oldest one that was formed by the Gakkel spreading center; therefore the latest Cretaceous and Paleogene sedimentary rocks in the northern segment of the Moma rift zone must have a different tectonic origin. Extension in the Moma rift zone propagated to the southeast. That is why the Cenozoic part appears here and not among the previously listed Cenozoic rifts.

[46] Earthquakes in the Moma graben cluster indicate a compressional regime (Imaev et al., 1998).

[47] Compression during the Oligocene–early Miocene (Drachev et al., 1998).

[48] Hinz et al. (1998) inferred that the main rifting phase happened in the Paleogene.

[49] The Jurassic extension is also inferred (Grantz et al. (1990).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe ***(continued)***								
68	Vilkitsky basin	172°E and 176°E, 71°N 75°N	25°	440	50–70	latest Cretaceous–Paleogene[50]	d1-k2-k22-g3	Grantz and May (1982), Grantz et al. (1990), Hamila et al. (1990), Sekretov (1998b), Shipelkevich et al. (1998)
69	Hope basin	165°W and 175°E, 67°N and 70°N	295°	900	120–240	latest Cretaceous–Paleogene and middle Miocene	d2-k3-k31-g4	Tolson (1987), Shipilov and Senin (1994), Natal'in (1999)
70	Middle Amur basin	130°E and 137°E, 47°N and 50°N	45°	240	120	latest Cretaceous–Miocene	d2-k3-k32-g4	Natal'in and Chernysh (1992), Varnavskiy et al. (1997, 1999)
71	Koolen-Seaward taphrogens	163°W and 170°W, 65°N and 67°N	340°–90°	>600	>100	middle Cretaceous	d2-k4-k42	Miller and Hudson (1991), Bering Strait Geologic Field Party, (1997), Dumitru et al., (1995)
71a	Koolen	170°W and 174°W, 65°N and 67°N	340°	210	100	middle Cretaceous (108–90 Ma)	d2-k4-k42	Natal'in (1979), Bering Strait Geologic Field Party (1997)
71b	Seward	163°W and 166°W, 65°N	90°	175	>25	middle Cretaceous (90–80 Ma)	d2-k4-k42	Miller and Hudson (1991), Amato et al. (1994), Bering Strait Geologic Field Party (1997), Dumitru et al. (1995), Hannula et al. (1995)
72	Krishna-Godavari	79°30′E and 82°30′E, 15°N and 17°N	NE-SW	350	80	earliest Cretaceous	k1, g2	Basu and Shrivastava (1981), Curray et al. (1982), Sahni (1982), Kumar (1983), Govindan (1984), Kumar et al. (1985)
73	Mahanadi	86°30′E, 20°30′N	ENE-WSW	200	100	Early Cretaceous	k1, g2	Basu and Shrivastava (1981), Jagannathan et al. (1983), Mishra et al. (1984)
74	West Bengal	87°E and 89°E, 20°N and 24°N	NNE-SSW	650	150	Early Cretaceous	k1, g2	Roybarman (1983), Saxena et al. (1984), Venkataramanan (1984)
75	Faridpur trough	88°E and 92°E, 22°N and 25°N	NNE-SSW	350	125	Early Cretaceous	k1, g2	Khan et al. (1991, Fig. 2)
76	Cauvery	78°30′E and 80°E, 9°N and 12°N	NE-SW	400	20–80 (for individual rifts within basin)	latest Jurassic?–earliest Cretaceous	k1, g2?	Basu and Shrivastava (1981), Curray et al. (1982), Sahni (1982), Kumar (1983)
77	Palk Strait	79°E, 9°30′N	NE-SW	100	40	latest Jurassic?–earliest Cretaceous	k1, g2?	Sahni (1982)
78	Palar	79°15′E and 80°15′E, 14°N and 16°N	NE-SW	150	40	latest Jurassic?–earliest Cretaceous	k1, g2?	Basu and Shrivastava (1981), Curray et al. (1982), Sahni (1982), Sastri (1984)
79	Amursk-Zeya basin	128°E and 130°E, 49°N and 52°N	30°	250	150	Late Jurassic–Early Cretaceous	d2-k4-k41 or d2-k3-k31	Kozlovsky (1988), Kirillova (1994)
80	Songliao basin[51]	120°E 0 127°E, 42°N and 49°N	35°	850	340	Late Jurassic and Early Cretaceous	d2-k4-k41 or d2-k3-k31	Tang Zhi (1982), Liu Hefu (1986), Li Desheng (1991), Tian Zai-Yi et al. (1992)
81	Erenhot	108°E and 119°E, 42°N and 45°N	90°–60°	1050	280	Jurassic–Early Cretaceous	d2-k3	Tang Zhi (1982), Liu Hefu (1986), Watson et al. (1987)

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[50] Sekretov (1998b) inferred the Albian sedimentary rocks to be the oldest ones in the Vilkitsky basin. Shipelkevich et al. (1998) proposed an Early Cretaceous age for the North Chukchi rifted margin.

[51] The Songliao and Amursk-Zeya basins lie on the same trend and reveal a common history. They are separated by an uplift, but in the Jurassic, they might have formed a single *rift zone*.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
82	Transbaykalian taphrogen	106°E and 121°E, 47°N and 55°N	60°–25°	1150	500	Late Jurassic–Early Cretaceous	d2-k3-k31(k32)-g4	Nagibina (1963), Marinov et al. (1973), Amantov et al. (1988), Zonenshain et al. (1990)[52], Ermikov (1994), Şengör and Natal'in (1996a)[53]
82a	Hailar	116°E and 120°E, 46°N and 49°N	35°	>260	240	Jurassic–Early Cretaceous	d2-k3	Tang Zhi (1982), Liu Hefu (1986), Watson et al. (1987)
83	Xuefeng (Yu-Wan) rift zone	112°E and 117°E, 32°N and 34°N	90°	500	250	Late Jurassic–Early Cretaceous	d2-k3-k32(k31)-g4	Liu Hefu (1986), Tian Zai-Yi et al. (1992)
84	Jianghan	111°E and 118°E, 26°N and 32°N	40°	800	550	Late Jurassic–Early Cretaceous	d2-k3-k32(k31)-g4	Tang Zhi (1982), Liu Hefu (1986), Tian Zai-Yi et al. (1992)
85	Shabwa	44°E and 48°E, 15°N and 16°N	NE-SW	100	50	Callovian	k1?, g2?	Beydoun (1988), Asharhan and Nairn (1997, p. 257)
86	Ma'rib-Al Jawf	44°E and 48°E, 13°N and 16°N	NW-SE	500	50	Callovian	k1?, g2?	Beydoun (1988), Asharhan and Nairn (1997, p. 257)
87	Karaastay-Turgay graben cluster	64°E and 62°E, 49°N and 50°N	20°[54]	150	50	Triassic–Jurassic	d2-k3-k32-g1	Zakharov and Udris (1971)
88	Alakol basin	83°E and 79°E, 45°N and 47°N	305°[55]	350	100	Late Triassic–Early Jurassic[56]	d2-k3-k31-g4	Basharina (1975), Allen et al. (1995), Şengör and Natal'in (1996a)
89	Anah	40°E and 42°E, 34°30'N	E-W	200	50	Late Triassic	k33, g1	Lovelock (1984), Alsharhan and Nairn (1997)
90	Euphrates[57]	39°E and 40°E, 34°20'N and 36°N	NW-SE	200	100	Late Triassic	k33, g1	Lovelock (1984), Alsharhan and Nairn (1997)
91	Rajmahal	87°E and 88°E, 24°N and 26°N	N-S	220	60	Middle Triassic	k411 or k32, g3	Veevers and Tewari (1995)
92	Narmada-Son	73°E and 80°E, 22°N	ENE-WSW	700	50	early Mesozoic? (with ancestry dating back to Late Proterozoic); Early Cretaceous in W	k411 or k32, g3	Basu and Shrivastava (1981), Biswas and Deshpande (1983), Babu (1984), Kaila (1986), Mishra (1989)
93	Kutch	69°E, 23°30'N	E-W	200	avg 100	latest Triassic–Early Jurassic	k1? g2	Biswas and Deshpande (1983), Mitra et al. (1983), Coumes and Kolla (1984, especially Fig. 8), Koshal (1984)
94	Sherkala graben	63°E and 68°E, 59°N and 64°N	35°	550	60	Early Triassic–Middle Triassic	d2-k3-k31-g3	Garetskiy (1972)

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[52] Zonenshain et al. (1990) interpreted the Transbaykal graben cluster as side effect of intraplate volcanism possibly related to the migration of a hotspot.

[53] Evolution of the Altaids and the Manchurides (Şengör and Natal'in, 1996a) allows an inference that the Transbaykal graben cluster is related to the system of left-lateral strike-slip faults.

[54] Trend of individual grabens.

[55] Normal faults have northeast strikes.

[56] Late Paleozoic (Permian) alkalic intrusions and dikes indicate the late Paleozoic beginning of extension in the Alakol basin (Allen et al., 1995).

[57] In the literature, this and the Anah rifts are given as Late Cretaceous structures variously inverted in the Miocene (e.g., Alsharhan and Nairn, 1997, p. 41). However, in an unpublished study, the members of the Geology Department of Istanbul Technical University, general geology division, have compiled 1:2000000 paleogeographic maps of the entire Arabian plate. On those maps it is clear that, already in the Late Triassic, the Euphrates and the Anah rifts have different, deeper facies than their surrounding regions. It seems that they formed in the Triassic as an eastern extension of the Palmyra trough. It is also clear from those maps that these structures were repeatedly rejvenated as rifts throughout the Mesozoic. Their late Cenozoic inversion was very gentle (e.g., see Alsharhan and Nairn, 1997, Fig. 2.16.D)

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
95	Chelyabinsk graben cluster	62°E and 64°E, 54°N and 57°N	20°	300	150	Early Triassic–Middle Triassic	d2-k3-k32-g3	Garetskiy (1972), Basharina (1975)
96	Kustanay (Kushmurun) graben cluster	64°E and 67°E, 52°N and 56°N	25°	400	150	Early Triassic–Middle Triassic	d2-k3-k32-g1	Zakharov and Udris (1971), Garetskiy (1972), Basharina (1975)
97	Kyzyltal-Mkhat graben cluster	66°E and 65°E, 50°N and 52°N	25°	200	45	Early Triassic–Middle Triassic	d2-k3-k32-g1	Zakharov and Udris (1971)
98	West Siberian taphrogen					Triassic	d2-k3-k31-g4	Surkov and Zhero (1981), Surkov (1986), Surkov et al. (1997), Aplonov (1988, 1989)
98a	Koltogor-Urengoy	76°E and 78°E, 57°N and 72°N	0°–20°	1800	5–80	Triassic	d2-k3-k31-g3	Surkov and Zhero (1981), Surkov (1986)
98b	Khuduttey	78°E and 75°E, 64°N and 68°N	350°	500	40	Triassic	d2-k3-k31-g3	Surkov and Zhero (1981), Surkov (1986)
98c	Yamal	73°E and 67°E, 67°N and 70°N	330°	350	50	Triassic	d2-k3-k31-g3	Surkov and Zhero (1981), Surkov (1986)
98d	Khudoseysky	84°E, 62°N and 69°N	0°	750	50	Triassic	d2-k3-k31-g3	Surkov and Zhero (1981), Surkov (1986)
98e	Ust-Tymsky	78°E and 80°E, 58°N and 60°N	30°	250	10–15	Triassic	d2-k3-k31-g3	Surkov and Zhero (1981), Surkov (1986)
98f	Chuziksky	79°E and 81°E, 57°N and 58°N	45°	200	20	Triassic	d2-k3-k31-g3	Surkov and Zhero (1981), Surkov (1986)
98g	Agansky	69°E and 78°E, 59°N and 63°N	40°	650	50	Triassic	d2-k3-k31-g3	Surkov and Zhero (1981), Surkov (1986)
99	North Sinai continental margin		ENE-WSW (concave to N)	100	90	Permian–Triassic	k411?, g3? k1?, g2?	Ginzburg and Gvirtzman (1979), Garfunkel and Derin (1984), Gvirtzman and Weissbrod (1984)
100	Levant continental margin (from Sinai corner to Lebanon-Syrian frontier)	34°E and 36°E, 31°N and 34°30′N	N-S to NNE-SSW	400	25 (avg)	Permian–Triassic	k31, g3? (mostly pure strike-slip!)	Goldberg and Friedman (1974), Freund and Derin (1975), Druckman (1984), Steckler and ten Brink (1986, and the references therein), Garfunkel (1989)
101	Yenisey-Khatanga trough	84°E and 114°E, 70°N and 77°N	60°–65°	1100	150–300	late Paleozoic–Triassic[58]	d2-k3-k32?	Bogdanov and Khain (1996, 1998)
102	Nurol	79°E and 75°E, 56°N and 61°N	325°	450	150	Late Carboniferous–Early Permian	d2-k3-k32	Kunin et al. (1984), Surkov (1986), Aplonov (1988, 1989, 1995), Allen et al. (1995), Şengör and Natal'in (1996a)
103	Nadym	70°E and 76°E, 63°N and 67°N	40°	450	200	Late Permian	d2-k3-k32	Surkov (1986), Aplonov (1988, 1989, 1995)[59], Allen et al. (1995), Şengör and Natal'in (1996a)
104	Pur-Gydan trough	73°E and 84°E, 68°N and 73°N	5°	650	400	late Paleozoic	d2-k3-k32[60]	Bogdanov and Khain (1998), Aplonov (1995), Aplonov et al. (1996)
105	Junggar	92°E and 82°E, 44°N and 47°N	280°	650	400	Permian	d2-k3-k31-g4	Lee (1985), Tian (1989), Peng and Zhang (1989), Carroll et al. (1990), Allen et al. (1995)

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[58] The eastern boundary of the Yenisey-Khatanga trough is the southern boundary of the Riphean rifted continental margin of the Angaran craton. The Yenisey-Khatanga trough was folded in the Late Triassic.

[59] Aplonov (1988, 1989) interpreted the basement of the Mesozoic West Siberian basin in the Nadym region as a residual oceanic basin, which we find difficult to follow.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
106	Turfan	95°E and 88°E, 42°N and 43°N	275°	500	100	Permian and Cenozoic	d2-k3-k31-g4	Allen et al. (1993, 1995): Carroll et al. (1995), Cunningham et al. (1996), Mattern (1998)
107	Son-Mahanadi	82°E and 86°E, 20°N and 23°N	NE-SW	600	30–200	Late Carboniferous–Early Permian	k411 or k32, g3	Datta et al. (1983), Casshyap and Srivastava (1987), Mishra (1989), Veevers and Tewari. (1995)
108	Damodar-Koel Valley	83°E and 88°E, 23°N	E-W	500	<100	Late Carboniferous–Early Permian	k411 or k32, g3	Basu and Shrivastava (1981), Datta et al. (1983), Veevers and Tewari (1995)
109	Koyana	74°E and 76°E, 15°N and 19°N	NNW-SSE	~500	<50	Gondwana? (Late Carboniferous–Jurassic)	k411 or k32, g3	Krishna Brahmam and Negi (1973)
110	Kurduvadi	74°E and 77°E, 15°N and 19°N	NW-SE	~500	<50	Gondwana? (Late Carboniferous–Jurassic)	k411 or k32, g3	Krishna Brahmam and Negi (1973)
111	Bjørnøja	18°E and 26°E, 72°30′N and 73°15′N	NE-SW	280	100 (max)	Early Permian (Artinskian–Kungurian); further rifting indicated in Callovian and Early Cretaceous	k31, g3 or k33, g1, k33, g1 for Cretaceous episode	Heafford (1988), Heafford and Kelly (1988), Kelly (1988), Dowling (1988)
112	Hammerfest	18°E and 26°E, 70°N and 72°30′N	NE-SW	400	80 (avg)	Early Permian (Artinskian–Kungurian); further rifting indicated in Callovian and Barremian–Aptian	k31, g3 or k33, g1 k33, g1 for Cretaceous episode	Ronnevik et al. (1975), Heafford (1988), Heafford and Kelly (1988), Kelly (1988), Dowling (1988)
113	Tromsø graben	17°E and 20°E, 70°N and 72°N	20°	285	15–100	Middle Devonian–Early Carboniferous	d2-k3-k32-g4	Dowdeswell (1988), Faleide et al. (1984), Ziegler (1988)
114	Nordkapp	25°E and 37°E, 72°N and 74°N	90°–45°	450	80	Devonian, Triassic	d2-k3-k31-g1 or g3	Dowdeswell (1988), Heafford and Kelly (1988), Kelly (1988), Ziegler (1988), Bogdanov and Khain (1996)
115	Varanger graben	36°E and 30°E, 71°N and 73°N	305°	250	50	Devonian, Triassic	d2-k3-k31-g4	Dowdeswell (1988), Bogdanov and Khain (1996)
116	East Edjin graben	24°E and 34°E, 76°N	75°	300	75	Devonian	d2-k3-k31?-g4	Bogdanov and Khain (1996)

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[60] The crust of the Pur-Gydan trough is characterized by high seismic velocities (6.75–7.15 km/s). In places, the lowermost levels of the crust are characterized by lower velocities. Bogdanov and Khain (1998) interpreted this seismic-velocity inversion as evidence for thrusting of oceanic crust on a continental fragment. Aplonov et al. (1996) inferred that the basement of the Mesozoic West Siberian basin in the Pur-Gydan region consists of a residual oceanic crust. We provide our interpretation according to which the Pur-Gydan trough is a pull-apart basin that originated within a late Paleozoic megashear zone between the Russian and Angara cratons (see Şengör et al., 1993; Allen et al., 1995; Şengör and Natal'in, 1996b).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
117	East Barent	39°E and , 70°N[61]	25°	1500	300–600	Middle Devonian–Late Carboniferous[62]	d1-k2-k22-g3	Shipilov and Senin (1994), Bogdanov and Khain (1996), Nikishin et al. (1996), Senin et al. (1998)
118	Knipovich graben	42°E, 73°N and 78°N	0°	350	50	Middle Devonian–Late Carboniferous	d1-k2-k22-g2	Bogdanov and Khain (1996)
119	Svyataya Anna trough	72°E, 76°N and 82°N	0°	650	100	Devonian	d1-k2-k22-g3?	Zonenshain et al. (1990), Bogdanov and Khain (1998)
120	Voronin trough	78°E and 90°E, 78°N and 83°N	345°	500	125–200	middle Paleozoic	d1-k2-k22-g3?	Bogdanov and Khain (1998)
121	Pechora-Kolvinsky rift cluster[63]	58°E and 53°E, 65°N and 69°N	340°	450	100	Devonian[64]	d1-k2-k22-g3	Milanovsky (1987b), Zonenshain et al. (1990), Lobkovsky et al. (1996), Malyshev (1998), Wilson et al. (1999)[65]
122	Dniepr-Donetsk aulacogen	38°E and 28°E, 48°N and 52°N	305°	900	100–150	Late Devonian	d1-k1?-g3	Milanovsky (1987b), Chekunov et al. (1992), Nikishin et al. (1996), Wilson and Lyashkevich (1996)[66], Kharitonov et al. (1998), Starostenko et al. (1999)
123	Peri–Caspian basin	44°E and 56°E, 46°N and 50°N	Trend of rifts go around the Caspian basin	900	600	Middle Devonian to Late Devonian[67]	d1-k2-k22-g3 d2-k4-k41-g3	Zonenshain et al. (1990), Nikishin et al. (1996), Brunet et al. (1999), Kostyuchenko et al. (1999)
124	Hanna trough	173°E, 70°N and 72°N	0°	300	240	Middle Devonian–Early Carboniferous and latest Cretaceous–Paleogene	d2-k4-k411 and d2-k3-k31-g4	Thurston and Theiss (1987), Grantz et al. (1990)
125	Najd keirogen[68]	37°E and 44°E, 23°30′N and 28°N	NNW-SSE	1000	300	late Vendian	k32, g1	Delfour (1970), Clark (1985), Agar (1986), Al-Husseini (1988), Brown et al. (1989), Şengör and Natal'in (1996a)
126	Shawaq	36°23′E and 36°50′E, 27°28′N and 27°18′N	ENE-WSW	50	12	late Vendian	k32, g1	Brown et al. (1989)
127	Mashhad	38°E and 38°40′E, 26°N and 26°40′N	NW-SE	90	25	late Vendian	k32, g1	Brown et al. (1989)

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[61] The northern limit of this rift is not well determined.

[62] Senin et al. (1998) found that the highest sedimentation rate in the East Barent rift was during the Permian and Triassic. This conclusion contradicts the Middle Devonian–Late Carboniferous age of rifting that has been inferred by other researchers. Bogdanov and Khain (1996) suggested that the Lower Cretaceous succession of the northern part of the East Barent rift contains flood basalts that are similar to those exposed in Franz Josef Land. The flood basalts of Franz Josef Land yield 159–139 Ma K-Ar ages.

[63] In some sources, this structure is referred to as an aulacogen. Structural maps of this rift zone can be found in Bogdanov and Khain (1996), however, the timing of rifting events is not clearly indicated.

[64] Lobkovsky et al. (1996) inferred three rift phases in the Early, Middle, and Late Devonian. Each phase was separated by rift inversion. The Early Ordovician rift event was also inferred by Nikishin et al. (1996).

[65] Wilson et al. (1999) supported the idea of the westward subduction beneath the Russian craton and the backarc origin of the Pechora-Kolvinsky graben cluster.

[66] Wilson and Lyashkevich (1996) have tentatively identified plume-related features of magmatic rocks and a 130–100-km-deep level of partial melting.

[67] Brunet et al. (1999) inferred several episodes of rifting. The Riphean and Vendian–Ordovician rifting events have been reconstructed on the basis of thick (6–7 km), seismically defined stratigraphic units underlying Devonian and younger rocks. The Riphean rifting was related to the main rifting phase of the Russian craton. If this inference is correct, then the Riphean rifts form a triple junction with the Pachelma aulacogen. Evidence for the Vendian–Ordovician rifting phase is unreliable.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
128	Jibal al Humayliyah	41°40′E, 25°40′N	NW-SE	30	10	late Vendian	k32, g1	Brown et al. (1989)
129	Jabal Dibiy	40°40′E and 41°25′E, 25°45′N and 26°30′N	NW-SE	125	15	late Vendian	k32, g1	Brown et al. (1989)
130	Jabal Şahuq	40°45′E and 41°15′E, 25°10′N and 25°40′N	NW-SE	75	5	late Vendian	k32, g1	Brown et al. (1989)
131	rift S of Bi'r Zurb ("Zurb well")	41°10′E and 42°15′E, 23°50′N and 24°20′N	NW-SE	120	10 (max?)[69]	late Vendian	k32, g1	Brown et al. (1989)
132	rift N of Bi'r Sija ("Sjia well")[70]	42°45′E, 23°40′N	NW-SE	25	5 (max)	late Vendian	k32, g1	Brown et al. (1989)
133	Budayyiah	43°35′E, 22°55′N	NW-SE	25	5 (max)	late Vendian	k32, g1	Brown et al. (1989)
134	Al Mishash	43°30′E, 24°30′N	NW-SE	70	7.5 (avg)	late Vendian	k32, g1	Brown et al. (1989)
135	Hormuz taphrogen[71]	47°E and 58°E, 18°N and 24°N	N-S (general strike of rifts)	1500	1000	Sturtian to Vendian (to Cambrian?) (640–535 Ma)	k31, g4, k32, g4	Stöcklin (1968, 1986), Berberian and King (1981), Zharkov (1984, p. 45–54), Davoudzadeh et al. (1986), Al-Husseini (1988, 1991), Rabu (1988), Motiei (1990), Şengör and Natal'in (1996a), Alsharhan and Nairn (1997, especially p. 65–86)[72]
136	Rub-al-Khali[73]	48°E and 54°E, 18°N and 24°N	NE-SW	800	200	Vendian?	k32?, g4, k21?, g2?	Rabu (1988)
137	South Oman–Ghaba[74]	54°E and 59°E, 18°N and 24°N	NE-SW	700	100 (avg)	Vendian?	k32?, g4 k33, g4	Rabu (1988)

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[68] The "Najd keirogen," i.e., a large zone of considerable thick-skinned strain containing a large number of major strike-slip faults (cf. Şengör and Natal'in, 1996b, p. 490 and footnote 8), as presented here may be misunderstood to imply that it consists entirely of small and narrow rifts filled with the sedimentary rocks of the Jubaylah and Beni Ghayy Groups and the Minawah Formation (Delfour, 1970; Clark, 1985; Agar, 1986; Brown et al., 1989). It is in reality a huge system of strike-slip faults hundreds of km wide and more than 1000 long as exposed (the "strike-slip orogen" of Agar, 1986, p. 259), of which the pull-apart basins form only a minute part. Taking only the sedimentary-rock–filled basins to define the rifts within the keirogen is too narrow a definition, for there are also numerous fault-bounded, syntectonically intruded granites, diorites, and gabbros and basin-filling andesites, dacites, alkalic basalts (mugearites), and rhyolites. All these seem to have intruded into extensional foci along the Najd strike-slip faults. However, their recognition on small-scale maps is unsafe, and every feature has to be considered by itself through the use of the available field descriptions. We have not undertaken to do this because (1) we had no time to accomplish the research required and (2) they are all small features that add little to the overall representation of the Najd keirogen rifts on our small-scale map.

[69] This rift basin has two subbasins separated by a long half horst. If the two basins are considered as one and the half horst is viewed as an inrabasinal feature, then the maximum width grows to 30 km!

[70] This rift is along the same Najd strike-slip fault zone as the Bi'r Zurb rift. Near the Bi'r Zurb rift there is another completely fault-bounded and tiny basin filled with the Jubaylah Group of rocks (see Brown et al., 1989, p. A32ff). It is likely that the Bi'r Sija and the Bi'r Zurb rifts were once one and that the tiny basin remnant in between is a witness to that.

[71] All references for the Hormuz taphrogen can also be used for its individual rifts. Unless there were specific references available to us on the individual rifts, we did not list those papers again that are tabulated for the whole taphrogen. The Hormuz taphrogen must be more extensive than here depicted, not only because its buried parts to the north still remain unknown, but also because a Late Devonian compressional event created N-S block uplifts closely paralleling the Kuwait Salt basin (McGillivray and Husseini, 1992). These uplifts must have been nucleated on older rifts. One piece of evidence for this interpretation is the tremendous thickening of the Lower Silurian Qalibah Formation in the Udaynan basin that sits on strike from the subsurface Devonian highs. The euxinic Qusaiba Shales underlying it also thicken at the same place (see Mahmoud et al., 1992).

[72] This book has a good bibliography to lead to further reading on particulars.

[73] Rub-al-Khali has been a shallow, essentially faultless depression throughout the Phanerozoic. No fault-bounded trough has yet been demonstrated under it as far as we know. The presence of such a rift has only been presumed owing to the persistent negative topography displayed by Rub-al-Khali in the Phanerozoic and its parallelism with the South Oman rift.

[74] The origin of this rift is still problematic. It may have formed after 616 Ma ago during the sinistral phase of the Najd Keirogen, because its orientation is incompatible with its dextral phase.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
138	Hormuz (sensu stricto)	53°E and 57°E, 25°N and 30°N	N-S	500	300 (max)	Sturtian (640–616 Ma)	k32?, g4 k33, g4	Fürst (1990)
139	Fahud	56°E and 57°E, 20°N and 23°N	N-S	300 (together with a salt-free rift S of salt basin)	85 (max)	Sturtian (640–616 Ma)	k32?, g4 k33, g4	
140	Jabal az Zannah basin[75]	52°E and 54°E, 24°N and 26°N	N-S	240	240	Sturtian (640–616 Ma)	k32?, g4 k33, g4	
141	Darang basin[76] (delimited by the main Zagros fault)	49°E and 53°E, 27°N and 34°N	N-S (in S) NW-SE (in N)	800	150 (max)	Sturtian (640–616 Ma)	k32?, g4 k33, g4	Ghavidel-Syooki (1990)
142	North Gulf Salt basin	50°E and 50°50′E, 23°30′N and 30°30′N	N-S	800	150	Sturtian (640–616 Ma)	k32?, g4 k33, g4	Al-Husseini (1991)
143	Kuwait	42°E and 46°E, 27°N and 31°N	N-S	450	50 (avg); widens northward	Sturtian (640–616 Ma)	k32?, g4 k33, g4	Al-Husseini (1991)
144	Bhima basin	76°E and 77°30′E, 16°30′N and 17°30′N	E-W to NW-SE	~50 for each of three subbasins	~55 for each of three subbasins	latest Middle Proterozoic to early Late Proterozoic (mostly ~800–700 Ma)	k32,g3	Kale and Phansalkar (1991)
145	Pranhita-Godavari	78°E and 82°E, 16°N and 20°N	NW-SE	700	30–60	Middle? Proterozoic; Late Carboniferous–Early Permian	k411 or k32, g3	Basu and Shrivastava (1981), Datta et al. (1983), Raiverman et al. (1985), Dutta (1987), Mishra et al. (1987), Naqvi and Rogers (1987), Veevers and Tewari (1995)
146	Volyn trough	26°E and 24°E, 49°N 53°N	335°	225	30–105	late Riphean–early Vendian	d1-k1-g3	Nalivkin and Yakobson (1985)
147	Ladozhsky aulacogen	30°E, 60°N and 62°N	320°	150	>30	middle Riphean	d1-k1-g1	Milanovsky (1987b), Zonenshain et al. (1990), Nikishin et al. (1996)
148	Botnichesky aulacogen	18°E and 25°E, 61°N and 65°N	5°–35°	480	150	middle Riphean	d1-k1-g3	Milanovsky (1987b), Nikishin et al. (1996)
149	Vozhe-Lachsky aulacogen	39°E and 37°E, 60°N and 62°N	320°	150	50	middle Riphean	d1-k1-g1	Milanovsky (1987b)
150	Kandalaksha graben	32°E, 67°N	305°	>150	>35	middle Riphean–early Vendian	d1-k1-g1	Nalivkin and Yakobson (1985), Milanovsky (1987b), Zonenshain et al. (1990), Nikishin et al. (1996)
151	Onezhsky aulacogen	36°E and 46°E, 62°N and 66°N	310°	650	25–30	middle Riphean–early Vendian	d1-k1-g3	Milanovsky (1987b), Zonenshain et al. (1990), Bogdanov and Khain (1996), Kostyuchenko et al. (1999)

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[75] This is a name we introduce to designate the large salt basin lying in the subsurface mostly offshore of the United Arab Emirates. The name is derived from the 114-m-high mound rising atop an Infracambrian salt dome, which is the most prominent topographic feature of the entire coast between the Qatar and the Musandam peninsulas. Sometimes the name of the mound is transliterated as "Jabal Dhanna." We chose to follow the transliteration used in the 10th edition of the *Times Atlas of the World* (2000).

[76] We introduce this name from the Darang 1 well that penetrates the Hormuz evaporites of this basin (Ghavidel-Syooki, 1990, Figs. 1 and 4).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
152	Keretsko-Pinezhsky aulacogen	42°E and 40°E, 64°N and 65°N	320°	150	50	middle Riphean–early Vendian	d1-k1-g4	Nalivkin and Yakobson (1985), Milanovsky (1987b), Bogdanov and Khain (1996)
153	Leshukontsky aulacogen	47°E and 41°E, 63°N and 66°N	305°	450	50–100	middle Riphean–early Vendian	d1-k1-g3	Milanovsky (1987b), Bogdanov and Khain (1996), Kostyuchenko et al. (1999)
154	Nizhnemezensky (Safonov) aulacogen	49°E and 44°E, 65°N and 67°N	305°	300	50	middle Riphean –early Vendian	d1-k1-g3	Milanovsky (1987b), Bogdanov and Khain (1996), Kostyuchenko et al. (1999)
155	Timano-Varangersky aulacogen	57°E and 44°E, 62°N and 68°N	300°–340°	1000	25–100	late Riphean	d1-k2-k22-g3	Milanovsky (1987b), Olovyanishnikov (1998)
156	Yarensky (Kotlassky) aulacogen[77]	47°E and 50°E, 61°N and 63°N	30°–70°	300	100	middle Riphean–early Vendian	d1-k1-g3	Nalivkin and Yakobson (1985), Milanovsky (1987b), Kostyuchenko et al. (1999)
157	Soligalichsky aulacogen[78]	41°E and 45°E, 59°N and 60°N	45°	300	50–100	middle Riphean	d1-k1-g1	Nalivkin and Yakobson (1985), Milanovsky (1987b), Nikishin et al. (1996), Kostyuchenko et al. (1999)
158	Moscovsky aulacogen	35°E and 40°E, 55°N	90°	300	100	middle Riphean	d1-k1-g3	Nalivkin and Yakobson (1985), Milanovsky (1987b)
159	Kresttsovsky (Valdaysky) aulacogen	31°E and 36°E, 54°N and 59°N	45°–70°	450	100–50	middle Riphean	d1-k1-g1	Milanovsky (1987b), Zonenshain et al. (1990), Kostyuchenko et al. (1999)
160	Kirovsky[79] (Kazhim) aulacogen	49E° and 53°E, 58°N and 62°N	25°	600	50	middle Riphean; Middle Devonian to beginning of Late Devonian	d1-k1-g1	Nalivkin and Yakobson (1985), Milanovsky (1987b)
161	Abdulinsky (Sernovodsk-Abdulino) aulacogen	52°E and 55°E, 54°N	280°	300	10–50	early Riphean–middle Riphean	d1-k1-g3	Nalivkin and Yakobson (1985), Milanovsky (1987b), Nikishin et al. (1996)
162	Kamsko-Belsky (Kaltasy) aulacogen	57°E and 54°E, 55°N and 59°N	30°	400	150	early Riphean	d1-k1-g3	Nalivkin and Yakobson (1985), Milanovsky (1987b)
163	Pachelma aulacogen	47°E and 38°E, 51°N and 55°N	305°	700	60–100	middle early Riphean; subsidence increased in Middle Devonian	Precambrian: d1-k1-g3, Devonian: d1-k1?-g3	Nalivkin and Yakobson (1985), Milanovsky (1987b), Nikishin et al. (1996), Kostyuchenko et al. (1999)
164	Dono-Medvedetsky aulacogen[80]	45° E and 47°E, 50°N and 51°N	25°	250	100	middle Riphean; Middle Devonian	d1-k1-g3	Nalivkin and Yakobson (1985), Milanovsky (1987b)
165	Igaro-Norilsk aulacogen	87°E and 94°E, 67°N and 70°N	20°	>500	>150	middle Riphean–late Riphean[81]	d1-k2-k22	Milanovsky (1987b), Zonenshain et al. (1990), Fedorenko et al. (1996)

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[77] The Yarensky and Soligalichsky aulacogens are also known as the Middle Russian rift (Nalivkin and Yakobson, 1985; Kostyuchenko et al., 1999).

[78] This rift is inverted. Inversion was in the late Paleozoic (Milanovsky, 1987b, Fig. 5b). Nikishin et al. (1996) inferred a late Vendian–Early Cambrian inversion. Nalivkin and Yakobson (1985) reported Late Silurian–Early Devonian basalts.

[79] Inverted in the late Mesozoic (Milanovsky, 1987b, Fig. 5v).

[80] Inverted in the late Mesozoic (Milanovsky 1987b).

[81] Milanovsky (1987b) inferred a Vendian inversion of the aulacogen. The next episode of tectonic activity was related to the Permian–Triassic trap magmatism that affected most of the Angara craton (Milanovsky, 1987b). Basalts and mafic intrusions reveal similarity with the plume-related magma sources (Fedorenko et al., 1996); however, no uplift of the region has been recorded (Czamanske et al., 1998). Siberian traps are interpreted to be the result of convective partial melting combined with lithospheric shearing and associated local extension (Czamanske et al., 1998). The lithospheric shearing could have been induced by large-scale shearing between the Russian and Angara cratons during the Late Permian (Şengör et al., 1993; Şengör and Natal'in, 1996b). Finally, the Igaro-Norilsk aulacogen was folded in the Late Triassic.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Eurasia—Asia and Eastern Europe *(continued)*								
166	Kotuysky (Maymechinsky)	98°E, 65°N and 71°N	0°	600	200	Riphean	d1-k2-k22	Milanovsky (1987b), Shpunt et al. (1982)
167	Udzhinsk aulacogen	115°E, 69°N and 73°N	0°	450	75	Riphean	d1-k2-k22	Milanovsky (1987b), Shpunt et al. (1982), Zonenshain et al. (1990)
168	Kyutyungdinsk aulacogen	125°E and 120°E, 70°N and 71°N	305°	200	50	Riphean	d1-k2-k22	Milanovsky (1987b), Shpunt et al. (1982), Zonenshain et al. (1990)
169	Vilyuy aulacogen	115°E and 124°E, 61°N and 64°N	45°	>300	150–250	middle Riphean and Middle Devonian	d1-k2-k22	Masaytis et al. (1975), Milanovsky (1987b), Zonenshain et al. (1990)
169a	Kempendyay graben	118°E and 124°E,	40°	275	135–160	middle Riphean and Middle Devonian	d1-k2-k22	Masaytis et al. (1975), Milanovsky (1987b), Zonenshain et al. (1990)
169b	Ygiattinsk graben	115°E and 120°E	55°	300	15–60	middle Riphean and Middle Devonian	d1-k2-k22	Masaytis et al. (1975), Milanovsky (1987b), Zonenshain et al. (1990)
170	Urinsky aulacogen	116°E and 117°E, 64°N and 61°N	30°	150	50	Riphean[82]	d1-k2-k22	Masaytis et al. (1975), Milanovsky (1987b)
171	Ulkan graben	134°E and 135°E, 56°N and 57°N	90°	75	50	2000–1550 Ma	d1-k1-k21-g2	Milanovsky (1987b)
Africa[83]								
1	Ngami-Mabebe depression (Kalahari)	22°E and 26°E, 18°30′S and 21°S	NW-SE	350	50 (max)	Holocene	k32, g4 and/or k33, g1	Scholz et al. (1976)
2	Limpopo Valley	30°E and 33°E, 21°30′S and 23°30′S	E-W to ENE-WSW	400	20–30	Pleistocene? to Holocene ("Kalahari")	k32, g4 and/or k33, g1	Molengraaff (1901), Daly et al.(1989)
3	Sumbu-Chishi faults	29°30′E and 30°30′E, 8°S and 10°30′S	NNE-SSW	360	30	Pleistocene?–Holocene	k32, g4	Baker (1971)
4	Kariba depression	28°E, 17°S	NE-SW	400	100 (max)	Pleistocene?–Holocene	k32, g4	Gough and Gough (1970), Scholz et al. (1976)
5	Upemba trough	27°E, 9°S	NNE-SSW	300	80	Pleistocene?	k32, g4	Baker (1971)
6	Lake Mweru (and Mweru Wantipa)	28°E and 30°E, 8°S and 10°S	NE-SW	200	~50	Pleistocene? (with older phases? See De Swardt)	k32, g4	De Swardt (1965), Daly et al. (1989), Girdler (1991), Schlüter (1997, Fig. 123)
7	Usangu or Buhoro Flats (Usangu-Fufu half rift)	34°E and 36°E, 6°30′S and 8°30′S	NE-SW	400	~50	Pliocene–Pleistocene	k5?, g1	Baker (1971), Pallister (1971), Schlüter (1997)
8	Shire-Urema-Dombe	33°E and 35°E, 15°S and 20°S	N-S (in N) NE-SW (in S)	550	~50	Pliocene or younger	k22, g3	Krenkel (1922, p. 26), Du Toit (1926, p. 347, 440–441), Mouta (1957), De Buyl and Flores (1986), Daly et al. (1989), Woolley (1991)
9	Muchinga escarpment (Luangwa Valley)	29°E and 33°E, 10°S and 15°S	NNE-SSW	650	100	late? Neogene	k32, g4	Vail (1967), Baker (1971)

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[82] Masaytis et al. (1975) reported sills of diabases in Cambrian rocks; therefore the aulacogen could have been reactivated in the Cambrian.

[83] For taphrogeny in Africa in general, see Clifford (1986), Chatellier and Slevin (1988), Kampunzu and Popoff (1991), Petters (1991), Burke (1996), Selley (1997), and Kinnaird (1998). Clifford (1986) is a very useful review of the hydrocarbon potential of the African rift basins, in addition to presenting otherwise publicly unavailable data on some of the basins.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
10	Carthaginian taphrogen[84]	8°E and 16°E, 32°N and 37°N	WNW-ESE	750	600	late Miocene–Holocene	k31, g4	Grandjacquet and Mascle (1978, p. 283), Dewey and Şengör (1979), Illies (1981), Winnock (1981), Jongsma (1991), Woodside (1991)
10a	Pantelleria (or Pantelleria-Malta)	12°E and 15°E, 35°30′N and 37°N	WNW-ESE	350	15	late Miocene–Holocene	k31, g4	Morelli (1973), Grandjacquet and Mascle (1978, p. 283), Dewey and Şengör (1979), Illies (1981), Winnock (1981), Boccaletti et al. (1989)
10b	Linosa	13°E, 36°N	WNW-ESE	60	15	late Miocene–Holocene	k31, g4	Morelli (1973), Grandjacquet and Mascle (1978, p. 283), Winnock (1981), Boccaletti et al. (1989), Jongsma (1991)
10c	Maamoura	11°E, 36°30′N	WNW-ESE	50	10	late Miocene–Holocene	k31, g4	Winnock (1981)
10d	Kuriates	11°E, 35°50′N	ENE-WSW	60	<10	late Miocene–Holocene	k31, g4[85]	Winnock (1981)
10e	Dimasse	11°E, 35°30′N	NE-SW	30	10 (max)	late Miocene–Holocene	k31, g4[85]	Winnock (1981)
10f	Mahdia	11°15′E, 35°25′N	ENE-WSW	100	15	late Miocene–Holocene	k31, g4[85]	Winnock (1981)
10g	Ksour es Saf	11°15′E, 35°10′N	E-W	40	<10	late Miocene–Holocene	k31, g4[85]	Winnock (1981)
10h	El Bahira	11°15′E, 35°N	ESE-WNW	20	5	late Miocene–Holocene	k31, g4[85]	Winnock (1981)
10i	Jaraffa	13°E and 14°E, 34°N and 35°N	ESE-WNW	130	20	late Miocene–Holocene	k31, g4	Winnock (1981)
10j	Tripolitanian	12°E and 14°E, 33°N and 34°10′N	ENE-WSW and ESE-WNW	300	40 (max) 20 (min)	late Miocene–Holocene	k31, g4	Winnock (1981)
10k	Tunisian "grabens"[86]	°30′E and 12°E, 34°N and 37°N	~14 grabens or rifts with general orientations from NW-SE to WNW-ESE	110 (max); 20 (min)	20 (max) 5 (min)	late Miocene–Holocene	k31, g4 and /or k422, g4	Burollet et al. (1978), Illies (1981), ben Ferjani et al. (1990)
11	Asyut	30°30′E and 31°40′E, 27°N and 27°30′N	WNW-ESE	80	10–20	late Miocene	k32,g1	Gigot et al. (1991)
12	Malta	14°20′E, 36°N	NE-SW	13 (on land)	15	middle to late Miocene	k411?, g3?	Pedley et al.(1978), Illies (1981), Reuther (1983, 1984)

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[84] We introduce this name to denote the entire extensional area in Tunisia and in the Pelagian block to its east, which has formed as a consequence of the opening of the Tyrrhenian Sea to the north (see Dewey and Şengör, 1979; Woodside, 1991). This area coincides roughly with the areal extent of the southeastern part of the marine empire of Carthage (as it went toward its final fall: 264–216 B.C.). The northern and northwestern parts embraced the marine realm in the triangle defined by Sardinia, Sicily, and Tunisia, in addition to the southern part of the Algerian-Provençal basin (see maps on p. 80 in Kinder and Hilgemann, 1982).

[85] The sedimentary fill has been folded by ~30% shortening as a consequence of the overall NW-SE strike-slip movement in the area. The same is true for the Dimasse, Mahdia, Ksour es Saf, and El Bahira troughs. In none of them was the shortening sufficient to invert the trough as a whole into a ridge. That is why we continue counting them as rifts.

[86] Most of the latest Miocene to Holocene normal-fault–bounded troughs of Tunisia are grabens and not rifts (in Şengör's [1995] sense and the sense we use the terms in this paper), having formed within a detached, shortening blanket of sedimentary rocks. Yet some are continuous with the Pelagian block rifts that have associated alkalic volcanicity, i.e., that disrupt the lithosphere. Those must be true rifts and not just grabens. At least a part of the latest Miocene–Holocene Tunisian extension must therefore be lithospheric.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
13	Gulf of Suez, African margin	32°20E and 34°10′E, 30°N and 28°20′N	NNW-SSE	300	60	latest Oligocene–earliest Miocene[87]	k1, g2	Patton et al. (1994), Schütz (1994), Montenat et al. (1986, 1998a, 1998b)
14	Red Sea, African margin	34°E and 44°E, 13°30′N and 28°N	NNW-SSE	1800	75 (max)	latest Oligocene[88]–Miocene	k1, g2	Choubert and Faure-Muret (1985), Bowen and Jux (1987), Crossley et al. (1992), Hughes and Beydoun (1992), Mitchell et al. (1992), Coleman (1993), Davison et al. (1998), Montenat et al. (1986, 1998a, 1998b), Rihm and Henke (1998), Şengör (this volume)
15	East African taphrogen	28°E and 40°E, 9°N and 17°S	N-S	3000	900	late Oligocene	d1-k1-g2 and g3	McConnel (1967), Matsuzawa (1969), Girdler (1973, 1991), Mohr (1974), Quennell (1982),[89] Daly et al. (1989), Chorowicz (1983, 1990), Kampunzu and Mohr (1991), Burke (1996), Frostick (1997), Rosendahl (1987), Schlüter (1997)
15-I	Eastern rift subtaphrogen	34°30′E and 41°E, 9°N and 5°S	NNE-SSW (in N) N-S (in center and S)	1900 (+160 for Kavirondo)	>100 to 20	late Oligocene in N; Miocene in S	d1-k1-g2 and g3	Baker et al. (1972)
15-Ia	Afar	39°30′E and 43°E, 9°N and 15°N	Triangular region: N-S along W margin NW-SE along W margin NE-SW in SW corner ~E-W in SE	750 (N-S) 450 (E-W, max)	see previous columns	middle Miocene	k1, g2	Bonatti et al. (1971), Mohr (1978), Choubert and Faure-Muret (1985), Huchon and Gaulier (1989), Tapponnier et al. (1990)[90]
15-Ib	Gregory rift valley (Tanzanian sector)[91]	34°30′E and 36°30E, 2°N and 5°S	NE-SW	350	20–40 (individual rift sectors)	middle Miocene? (pre–8.1 Ma)	d1-k1-g2 and g3	Matsuzawa (1969), Pallister (1971), Hay (1978), Mauritsch and Pondaga (1985), Dawson (1992)
15-Ic	Pangani (actually forming a virgation with Oljori rift)	37°E and 38E, 3°20′S and 5°S	N-S with a dogleg at ~4°45′S	160	<20 N of dogleg ~40 S of it	middle Miocene? (pre–8.1 Ma)	d1-k1-g2 and g3	Pallister (1971), Dawson (1992)
15-Id	Gregory rift valley (Kenyan sector)	34°E and 38°E, 2°N and 5°S	N-S	1050	75–50	late Oligocene in N; early to middle Miocene in S	d1-k1-g2 and g3	Shackleton (1955), Matsuzawa (1969), de Heinzelin (1983), Baker (1986), Williams and Chapman (1986), Bosworth (1987), Achauer et al. (1992), Bosworth et al. (1992), Smith (1994)

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[87] Determining the age of rifting depends on (1) the correlation of the earliest rift-filling (cf. Montenat et al., 1998a, 1998b) red siltstones and mudstones with several sandstone and conglomerate beds at Abu Zenima on the Asian margin (33°6E, 29°3′N), which received the name of Abu Zenima Formation (the so-called A_1 Group in Montenat et al.'s [1986] scheme), and (2) the age of the rift-filling red sediments (see the detailed discussion in Patton et al., 1994, p. 24).

[88] If the Lower Rudeis Formation along the coast of the Ethiopian Red Sea does extend down into the top of the Oligocene (cf. Hughes and Beydoun, 1992).

[89] This is a handy volume for a collection of papers on the East African taphrogen, but falls short of its promise of collecting truly benchmark papers. For bibliographies on the history of studies on East African rift valleys, see Lobitzer (1981, 1982) and Mohr (1999).

[90] The literature on the Afar is immense and multifaceted in addition to being international. The papers cited here aim at introducing the reader to the general area, basic geologic history, and currently debated topics. In addition, the reader should consult the literature cited for the Ethiopian rift valley and the Red Sea.

[91] This rift "segment" forms a virgation (in African rift literature known as "divergence") with the Lake Eyasi rift, Yaida rift, Balangida-Manyara rift, and Bahi rift as branches.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
15-Ie	Ethiopian rift valley	37°E and 41°E, 5°N and 9°N	NNE-SSW	500	>100 in N 30 in S	late Oligocene	d1-k1-g2 and g3	Pilger and Rösler (1975, 1976), Williams et al. (1986), WoldeGabriel et al. (1990)
15-Ie1	Chilwa	35°45′E, 14°S and 16°S	NNE-SSW	200	50	late Miocene? or younger?	k32?, g1	Baker (1971)
15-If	Kavirondo	35°E, 0°30′S	ENE-WSW	160	40	late Miocene	d1-k1-g2 and g3	Shackleton (1951), Jones and Lippard (1979)
15-II	Western rift subtaphrogen	28°E and 35E, 6°N and 20°S	NE-SW (6°N to 0°) N-S (0° to 5°S) NW-SE (5°S to 10°S) N-S 10°S to 20°S	3000	20–100	early Miocene?; middle to late Miocene?	d1?-k1?-g2[92]	Pouclet (1978), Chorowicz and Na Bantu Mukonki (1980), Ebinger (1989), Burke (1996)
15-IIa	Lake Rukwa	31°E and 33°E, 7°S and 8°30′S	NW-SE	350	45–60	Neogene (probably middle to late Miocene)	k32, g3	Chorowicz (1989), Rosendahl et al. (1992), Wheeler and Karson (1994)
15-IIb	Albert rift (including Virunga)	29°E and 32E, 6°N and 0°	NNE-SSW	650	45–75	early Miocene (Gautier); middle to late Miocene (Pickford et al.)	d1?-k1?-g2	McConnel (1959), Gautier (1965), Maasha (1975a, 1975b), Pouclet (1980), De Mulder (1985), Pickford et al. (1993)
15-IIc	Lake Kiwu rift system (including Ruzizi rift)	28°E and 30E, 1°S and 3°30′S	NNE-SSW (main) NW-SE (Ruzizi) NW-SE (auxiliaries)	275 (along trend); auxiliaries 100 in addition	50 (individual rift segments, including auxiliaries)	early Miocene? or middle to late Miocene (by a link via Albert rift)	d1?-k1?-g2	Peeters (1957), Baker (1971, p. 547), Moeyersons (1979), Chorowicz and Na Bantu Mukonki (1980), Pouclet (1980), Chorowicz and Thouin (1985)
15-IId	Lake Tanganyika	29°E and 31°E, 3°S and 9°S	NNW ~N-S (N half) NNW-SSE (S half)	550	20–60	early Miocene (>20 Ma)	k32, g3	Chorowicz and Na Bantu Mukonki (1980), Le Fournier et al. (1985), Burgess et al. (1988), Ebinger (1989), Rosendahl et al. (1992)
15-IId1	Luama "faults"	28°E, 4°S	NW-SE (some faults strike NE-SW)	250	80	Miocene	k32, g3	Baker (1971)
15-IIe	Lake Malawi	33°30′E and 35°30′E, 9°S and 15°30′S	N-S NNW-SSE (northernmost tip) NNW-SSE (S tip)	700	50–75	late Miocene?	k32, g3	Chorowicz and Sorlien (1992), Rosendahl et al. (1992)
16	Somali coast of Gulf of Aden	43°E and 51°E, 11°N and 12°N	ENE-WSW	850	~80	early Oligocene	k1, g2	Beydoun (1970), Bosellini (1989), Bott et al. (1992), Hughes and Beydoun (1992), Fantozzi and Sgavetti (1998)
17	Atbara (including Fadniya, Wad Burwa, and Qeili rift basins)	33°30′E and 34°45′E, 17°30′N and 15°N	NW-SE (Atbara) N-S (Fadniya, Wad Burwa, Qeili make up a chain of rifts with individual NNE trends)	110 (Atbara) 200 (cumulative for N-S group)	<50	Mesozoic exists, but role unclear! Cenozoic	k32? g4	Wycisk et al. (1990), Salama (1997)
18	Grein-Kafra	9°E and 12°45′E, 17°30′N and 23°N	NNW-SSE	675	40–60	late Albian	k21, g2 (k32?, g4?)	Binks and Fairhead (1992), Genik (1992), Guiraud and Maurin (1992), Wilson and Guiraud (1992), Giraud et al. (1992)
19	Bongor	16°E, 10°N	E-W, with flat sinusoidal shape	320	85	Albian	k21, g2 (k32?, g4?)	Genik (1992), Guiraud and Maurin (1992), Giraud et al. (1992)

[92] Burke (1996) suggested k421 and /or k422 and g3, but timing is problematical.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
20	Humar	30°30′E and 31°15′E, 16°30N and 17°45N	NNW-SSE	150	50	Albian	k32, g1	Bussert et al. (1990)
21	Salamat	21°30′E, 10°30′N	ENE-WSW	200	30 (max)	Albian	k32, g4 (similar to Ridge basin, California)	Genik (1992), Giraud et al. (1992)
22	Rio del Rey	8°25′E and 9°10′E, 4°N and 5°N	WNW-ESE	75	>100	latest Aptian–Albian	k1, g2	Logar et al. (1983, p. I-58–I-64), Ala and Selley (1997)[93]
23	Douala	9°10′E and 10°10′E, 3°10′N and 4°45′N	NW-SE (curvi-planar, convex to NE)	200 (along the arc)	90	latest Aptian–Albian	k1, g2	Logar et al. (1983, p. I-58–I-64), Ala and Selley (1997)
24	Benue	5°E and 14°E, 5°N and 11°N	NE-SW	1000	230 (max) 15 (avg) <50 (min)	Aptian–Albian?[94]	k21, g2	Burke et al. (1971, 1972), Ajakaiye and Kogbe (1981), Whiteman (1982), Guiraud and Maurin (1992), Giraud et al. (1992)
25	Mossamedes	11°45′E and 13°E, 13°S and 17°S	NNE-SSW	200	<100	Aptian? Albian?	k1, g2	Franks and Nairn (1973)
26	Termit (including Tenere and Tefidet)	8°E and 15°E, 13°N and 22°30′N	NW-SE	1200	220 (Termit) 55 (Tenere) 45 (Tefidet)	latest Aptian	k21, g2 (k32?, g4?)	Binks and Fairhead (1992), Genik (1992), Guiraud and Maurin (1992), Wilson and Guiraud (1992)
27	Doba	14°45′E and 18°E (witha narrow extension to 21°E) 8°N and 9°N (with an extension to10°N)	E-W (with a narrow ENE-WSW extension)	300 (360 including narrow strip along Borogop fault)	150 (max)	late Aptian	k32, g4	Genik (1992), Guiraud and Maurin (1992)
28	Doseo	17° and 23°E, 8°N and 10°30′N	ENE-WSW	700	80	Aptian	k32, g4	Genik (1992), Guiraud and Maurin (1992)
29	Bida	3°E and 7°30′E, 7°N and 12°N	NW-SE	550	100 (avg) ~150 (max) <50 (min)	Early Cretaceous	k21, g2 (k32?, g4?)	Genik (1992)
30	Gao	0° and 2°E, 15°N and 19°30′N	NW-SE (in S) NE-SW (in N)	550	<100	Early Cretaceous	k21, g2 (k32?, g4?)	Genik (1992)
31	Melut (including North Melut and White Nile, but excluding Bara)	31° and 35°E, 8°N and 13°N	NW-SE	650	>100 (max)	Early Cretaceous	k33,g4	Browne et al. (1985), Wycisk et al. (1990), McHargue et al. (1992)
32	Malakal	31°45′E, 9°30′N	NW-SE	50	25	Early Cretaceous?	k33, g4	Wycisk et al. (1990)
33	Kan	32°E, 9°N	NW-SE	75	25	Early Cretaceous?	k33, g4	Wycisk et al. (1990)
34	Pibor	33°30′E, 6°N	NW-SE	160	~80 (stem) 25 (each NW-trending branch)	Early Cretaceous?	k33, g4	Wycisk et al. (1990)
35	Cuanza (also referred to as Angola basin)	13°E and 14°30′E, 7°45′S and 11°S	NNW-SSE	300	120	pre-Aptian Neocomian?[95]	k1, g2	Franks and Nairn (1973), Logar et al. (1983, p. I-46–I-57), Ala and Selley (1997)

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[93] Ala and Selley (1997) is only an inadequate summary of Logar et al. (1983). We recommend Logar et al. to those having access to it.

[94] Berriasian according to different age estimate of Bima Formations by Guiraud and Maurin (1992).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
36	Gabon	8°30′E and 10°45′E, 1°15′S and 4°S	NNW-SSE (dominant structure trend and bounding normal faults)	600	220 (max in N subbasin) 110 (max in S subbasin)	Neocomian	k1, g2	Vidal (1980), Logar et al. (1983, p. I-46–I-57), Teisserenc and Villemin (1989), Ala and Selley (1997)
37	Bas Congo–Cabinda (also known as Congo[96] and Cabinda-Angola basin)	10°30′E and 13°20′E, 4°S and 7°45′S	NNW-SSE	500	100 (max)	Neocomian (latest Jurassic?)[97]	k1, g2	Franks and Nairn (1973), Brice et al. (1982), Logar et al. (1983, p. I-46–I-57), Clifford (1986, especially Figs. 28, 32, and 33),[98] Ala and Selley (1997)
38	Orange River	13°30′E and 18°30′E, 26°S and 35°S	NNE-SSW	1200	300	Late Jurassic? Early Cretaceous? (pre–late Hauterivian)	k1, g2	Siesser et al. (1974), Dingle (1982), Gerrard and Smith (1982), Ala and Selley (1997)
39	Abidjan (more rarely known as Ivory Coast basin)	2°30′W and 7°W, 3°N and 5°30′N	NW-SE (strike of normal faults) NE-SW (strike of bounding fracture zones)	400 (along normal fault)	150	latest Jurassic–Early Cretaceous?[99]	k32, g3	Burke (1969, 1971), Machens (1973), Delteil et al. (1974), Gorini and Bryan (1976)
40	Dahomey (also known as Togo-Dahomey basin)	0° and 5°E, 6°30′N and 8°N	ESE-WNW	500	~250 (max)	latest Jurassic–Early Cretaceous?[99]	k32, g3	Burke (1969, 1971), Machens (1973), Delteil et al. (1974), Gorini and Bryan (1976), Petters (1981), Kesse (1986)
41	Walvis	12°E and 15°E, 21°S and 26°S	NNE-SSW	500	~250	Late Jurassic?	k1, g2	Dingle (1982)
42	Sirte Rise	17°E and 18°E, 33°N and 35°N	NNW-SSE (continuation of the E wing of Sirte rift)	220	100	Late Cretaceous?	k21?,g2?	Finetti (1982)
43	Sirte (or Sirt)	15°E and 24°E, 25°N and 32°N	NNW-SSE	1200	800	Tithonian-pre-Cenomanian[100]	k21?,g2?	Goudarzi (1980), van Houten (1983), Anketell and Kumati (1991), Del Ben and Finetti (1991), Ibrahim (1991), Rossi et al. (1991), Suleiman et al. (1991), Guiraud and Maurin (1992)
44	Bara	30° and 31°30E, 12°30′N and 14°N	NW-SE	160	30	Kimmeridgian–Tithonian	k33?,g4	Wycisk et al. (1990)
45	Kosti (including Mahbuba)	31° and 32°30E, 12°30′N and 14°N	NW-SE	150	30	Kimmeridgian–Tithonian	k33? g4	Wycisk et al. (1990)

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[95] Depends on the age of the continental Lower Cuvo or the "Red Cuvo" Formation that underlies the equally continental Upper Cuvo, which in turn lies under the Aptian evaporites (cf. Logar et al., 1983, p. I-15–I-16).

[96] The name "Congo" is best avoided for this coastal basin in case it gets confused with the much larger inland Congo basin.

[97] Depends on the age and tectonic position of the Nacanga siliceous sandstones and limestones that underlie the partly lower Neocomian Lucula Formation, generally acknowledged to be the first rift fill (see Fig. I-30 in Logar et al., 1983).

[98] The sections illustrated by Clifford are far more realistic than the summary section in Logar et al. (1983, Fig. I-29) showing all grabens as basement synclines with no faulting!

[99] The indecision here is because of a problem similar to that in the dating of the inception of rifting in the Benue trough. In the Abidjan basin, the first transgression is of middle to late Albian age (Delteil et al., 1974). Its deposits cover a thick (472 m in the Ivory Coast, >2000 m in the Dahomey basin) terrestrial clastic unit including conglomerates, sandstones, and claystones, which sits on the Precambrian basement and is called "Série versicolore" (Machens, 1973). The age of this unit is not known, but its higher parts may reach into the Aptian-Albian and its base may extend down into the Upper Jurassic. Depending on what the age of the lowest parts of the Série versicolore turns out to be, the age of initial rifting in the Abidjan basin will be established. Our preference is to date it into the Early Cretaceous, close to Aptian if not Aptian, owing to its obvious relationship to the South Atlantic rifting.

[100] The Tithonian age may represent an independent rifting event. The pre-Cenomanian age (Aptian or Berriasian per Guiraud and Maurin [1992]) refers to the main rifting event.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
46	Blue Nile (contiguous with Khartoum)	33° and 35°E, 12°N and 14°30′N	NW-SE	400	50	Kimmeridgian–Tithonian	k33? g4	Wycisk et al. (1990), Guiraud and Maurin (1992)
47	Khartoum (contiguous with Blue Nile)	32°E and 33°30′E, 13°30N and 17°N	N-S NNE-SSW (S half)	340	40–50	Kimmeridgian–Tithonian	k32? g4	Wycisk et al. (1990), Salama (1997)
48	Guiné Bissau–Freetown	19°W and 12°W, 7°N and 12°N	NW-SE	570	300 (max)	Late Jurassic	k1, g3	Jones and Mgbatogu (1982), Clifford (1986, especially Fig. 27), Chalokwu et al. (1995)
49	Liberian	9°W and 12°W, 3°N and 7°N	NW-SE (general) E-W (in S) Irregular in middle NNW-SSE (in N)	660	120	Late Jurassic	k1, g3	Behrendt et al. (1974)
50	Misaha	27°30′E and 28°30′E, 21°N and 23°30′N	NNW-SSE	300	100	Late Jurassic	k32? g4	Wycisk (1987), Wycisk et al. (1990)
51	Marmarican taphrogen[101]	25°E and 31°30′E, 28°30′N and 31°N	WNW-ESE (general) WNW-ESE to NW-SE (individual rifts)	250	15–70 (individual rifts)	Middle Jurassic–Late Jurassic (initial rifting in center) Early Cretaceous (Aptian?) (main rifting)	k32, g4 and k33	Hantar (1990), Kerdany and Cherif (1990), Klitzsch (1990), Said (1990)
52	Kagmar	30°E, 14°45′N	E-W	70	25	late Mesozoic	k32, g1	Wycisk et al. (1990)
53	BagBag	30°15′E, 15°30′N	WNW-ESE	80	30	late Mesozoic	k32, g1	Wycisk et al. (1990)
54	Hosh	31°30′E, 17°N	NE-SW	60	20	late Mesozoic	k32, g1	Wycisk et al. (1990)
55	Salamat	31°30′E, 17°30′N	NE-SW	60	<20	late Mesozoic	k32, g1	Wycisk et al. (1990)
56	Gilif	32°30′E, 17°30′N	E-W to WNW-ESE?	60	40	late Mesozoic	k32, g1	Wycisk et al. (1990)
57	Anza	35°E and 40°E, 5°N and 7°S	NW-SE	850	~100 (narrowing to NW)	Middle Jurassic early Cenozoic rejuvenation	k1?, g2? or k33?, g1?	Winn et al. (1993), Bosworth and Morley (1994)
58	Sicily-Malta Escarpment	15°E and 17°E, 35°N and 37°30′N	NNW-SSE	340	35 (max)	Middle Jurassic	k1?, g2? or k33?, g1?	Finetti (1982)
59	Algoa (including submarine part)[102]	26°E, 34°S	NW-SE (plan convex to NE)	250	100 (max)	Middle Jurassic	k32, g4	Dingle (1976), Tankard et al. (1982), Şengör (1995)
60	Gamtoos (including submarine part)	25°E, 34°S	NNE-SSW	200	75	Middle Jurassic	k32, g4	Dingle (1976), Tankard et al. (1982), Şengör (1995)

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[101] This is a name introduced here for the first time for a group of small E-W to ESE-WNW trending rifts connected to one another by NW to NNW-trending strike-slip faults in northern Egypt. To our knowledge this taphrogen had not been recognized before, though many of its constituent rifts had been. We chose the name from the land of Marmaridae (~ time of Octavianus Augustus), located between Cyrenaica and the Nile Valley, where the taphrogen we recognize is best developed. The Marmaridae were said to be swift runners and immune to snake poison (e.g. Lucan).

[102] The easternmost part of what is commonly known as the Outeniqua basin (Scrutton and Dingle, 1976). It is now clear that this basin consists of a series of convex-to-the-northeast horst-and-graben blocks (Tankard et al., 1982, Fig. 12-2, and, following them, Şengör, 1995, Figs. 2-17, A–C) that can be traced onshore. We here use the names of the onshore basins also for their offshore continuations.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
61	Mossel Bay–Knysna–Plettenberg–Alphard Bank (including submarine part)[103]	20°30′E and 24°30′E, 34°S and 36°S	NW-SE (convex to NE)	350	250 (Alphard wider than the other)	Middle Jurassic	k32, g4	Dingle (1976), Tankard et al. (1982), Şengör (1995)
62	Oudtshoorn	22°E, 33°40′S	E-W	200	40 (max)	Middle Jurassic	k32, g4	Tankard et al. (1982), Şengör (1995)
63	Al Mado–Darror (or Almado-Daroor-Sagaleh)	47°30′E and 51°E, 9°30′N and 12°N	N-S (but it is nearly equant)	~300	~300	Late Triassic–Early Jurassic	k1?, g2?[104]	Dualeh et al. (1990), Mbede and Dualeh (1997)
64	Berbera-Borama	43°E and 47°E, 10°N and 11°N	E-W	~400	100	Late Triassic–Early Jurassic	k1?, g2?[104]	Dualeh et al. (1990), Mbede and Dualeh (1997)
65	Senegal (also known as Senegal-Mauritania basin)	12°30′W and 18°W, 12°N and 21°N	NNW-SSE	900	600 (max) 250 (min)	Triassic? Early Jurassic?[105]	k1, g3	Jansa and Wiedmann (1982), Weigel et al. (1982), Wissmann (1982)
66a	Cyrenaican-Nile margin	20°E and 32°E, 31°30′N and 33°N	E-W	800	~100	Late Triassic	k33?, g4	Biju-Duval et al. (1974)
66b	Gabes-Tripoli-Misurata	11°E and 16°E, 32°30′N and 34°30′N	WNW-ESE	550	150 (max)	Late Triassic	k33?, g4	Finetti (1982)
67	Tarfaya-Aaiun	12°W and 16°W, 23°N and 29°N	NNE-SSW	700	350 (max: along ~26°N)	Triassic	k1, g3	Jansa and Wiedmann (1982), Ranke et al. (1982), Heyman (1989)
68	Lakia	20°E and 32°30′E, 17°N and 23°N	E-W	1250	400	Permian–Triassic	k423, g3 (g4?)	Schandelmeier et al. (1987), Petters (1991, Fig. 8.34, on the basis of Schandelmeier et al., 1987)
69	Belet Uen	42°E and 46°E, 2°30′N and 8°N	NNW-SSE	600	100 (in S) 30 (in N)	"Karoo age"	k1?, g2?	Bosellini (1989), Dualeh et al. (1990)
70	Somali Coastal Plain (including Somali embayment)	43°E and 50°E, 0° and 8°N	NNE-SSW ENE-WNW (El-Hammure escarpment)	1100 (Somali embayment) 500 (to ENE and WSW)	200 (avg) 450 (max)	Permian–Triassic?[106]	k1?, g2?	Peterson (1985), Coffin and Rabinowitz (1988), Dualeh et al. (1990), Mbede and Dualeh (1997)
71	Mazagan-Essaouira-Agadir	8°W and 12°30′W, 29°N and 34°N	NNE-SSW	600	150 (max)	Permian? Triassic Early Jurassic	k1, g3	Jansa and Wiedmann (1982), Hinz et al. (1982), Heyman (1989)

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[103] The tiny Heidelberg basin and at least three other basins located along the Worcester fault (Tankard et al., 1982, Fig. 12–2) seem to be tectonic continuations of the Mossel Bay–Knysna–Plettenberg rift (but *not* the Alphard Bank rift). Though the Worcester fault is shown on our maps, the basins are too small to be included. Furthermore, although the Alphard Bank rift and the Mossel Bay–Knysna–Plettenberg rift seem to be two distinct rift basins in communication with one another at only one gap, we treated them as one basin system because of that communication.

[104] If this mechanism is applicable, age may be Jurassic.

[105] Ambiguity results from ignorance of the age of possible (seismically established) rift-fill sediments below the continental sediment prism (see Weigel et al., 1982, Fig. 17). Templeton (1971) interpreted their age as Triassic, but Wissmann (1982) and Emery and Uchupi (1984, p. 327–328) found Jurassic a more appropriate interpretation. Jansa and Wiedmann (1982) refrained from dating the rifting episode altogether owing to lack of data (see their Fig. 14 emphasizing the ambiguity; also see their Table I).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
72	Entebbe	32°30′, 0°	E-W	8	1	Permian or later?	k423?, g1? (only part of larger rift?)	Schlüter (1997)
73	Bugiri[107]	33°30′, 0°15′N	NW-SE	? (on the order of a few)	similar to Entebbe	Permian or later?	k423?, g1? (only part of larger rift?)	Schlüter (1997)
74	Lindi (known as "Lindi fault trend")	39°E and 40°E, 8°S and 11°S	NNW-SSE	300	50	Pre-Triassic[108] Early Jurassic reactivation Late Jurassic–Early Cretaceous faulting	k423?, g2, g3?	Coffin and Rabinowitz (1988), Mbede and Dualeh (1997)
75	Nara trough	3°W and 7°30′W, 15°N and 17°N	WSW-ENE (along trend of Gourma aulacogen)	440	~60	Paleozoic?	k421, g1 (or k422, g1?)	Roussel and Lesquer (1991)
76	Luangwa	30°E and 35°E, 10°S and 14°30′S	NNE-SSW	600	100 (max)	Early Permian	k32, g3, k423?, g4?	Daly et al. (1989), Veevers et al. (1994)
77	Kafue	25°E and 28°E, 15°S and 17°S	NE-SW	450	90 (max)	Early Permian	k32, g3	Daly et al. (1989), Veevers et al. (1994)
78	Tuli (also known as "Tuli syncline")	29°E, 21°30′S	ENE-WSW	220	70 (max)	Early Permian	k423?, g4?	Cox (1970), Daly et al. (1989), Veevers et al. (1994)
79	Nuanetsi (also known as "Nuanetsi syncline")	31°E, 22°S	WNW-ESE	80	40	Early Permian	k423?, g4?	Cox (1970), Daly et al. (1989), Veevers et al. (1994)
80	Zambezi (Coastal)	32°E and 34°E, 19°S and 22°S	NE-SW	350	40 (max)	Early Permian	k423?, g4?	De Buyl and Flores (1986), Daly et al. (1989), Veevers et al. (1994)
81	Soutpansberg	30°30′E, 23°30′S	ENE-WSW	160	20 (max in E)	Early Permian	k423?, g4?	Haughton (1963), Cox (1970), Daly et al. (1989), Veevers et al. (1994)
82	Mid-Zambezi	26°E and 30°E, 16°S and 19°S	NE-SW	~500	~50–100 (two parallel basins)	Early Permian (with tillites at base)	k32, g3 k423?, g4?	Daly et al. (1989), Orpen et al. (1989)
83	Lower Zambezi	30°E and 36°E, 16°S and 20°S	ESE-WNW to 35°E NNW-SSE to 20°S	>500 (in N) 400 (in S)	100 <200 (in SE sector)	Early Permian Early Cretaceous refaulting in S	k32, g3 k423?, g4?	De Buyl and Flores (1986), Daly et al. (1989), Orpen et al. (1989)
84	Luano-Lukusashi	29°E and 30°45′E, 13°30′S and 15°S	NE-SW	300	30 (max)	Permian	k32, g3 k423?, g4?	Daly et al. (1989), Veevers et al. (1994)

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[106] This age is what is commonly interpreted, despite the fact that the earliest known sedimentary deposits are the 120-m-thick quartz sandstones resembling the continental Late Triassic?–Early Jurassic Adigrat sandstones in the Brava-1 well (for location, see Coffin and Rabinowitz, 1988, Fig. 1, loc. S13; Mbede and Dualeh, 1997, Fig. 2). In the Obbia-1 and the El Cabobe wells (for location, see Mbede and Dualeh, 1997, Fig. 2), the earliest stratum reached is the Hamanlei Formation of Jurassic age (Dualeh et al., 1990, Fig. 3). However, both Kamen-Kaye (1978) and Kamen-Kaye and Barnes (1978) thought that they have seen Permian–Triassic palynomorphs in the shale overlying the "Adigrat." Coffin and Rabinowitz (1988), Dualeh et al. (1990), and Mbede and Dualeh (1997) have continued adhering to the "Adigrat" hypothesis without further ado.

[107] There are also Karoo deposits south and southwest of Irumu (29°49′E, 1°32′N) in northeastern Congo (formerly Zaire and Congo again before that) embedded in Precambrian basement. The outcrop pattern shows no fault control (Schlüter, 1997, Fig. 77), so they are not included here.

[108] The two existing wells penetrating into the lower parts of the basin, namely, the Kizimbani-1 and Mandawa-7, reached nothing older than Triassic (Coffin and Rabinowitz, 1988, p. 13, 15; Mbede and Dualeh, 1997, Fig. 9). Coffin and Rabinowitz (1988, p. 13–15) implied Carboniferous onset of rifting, but without evidence.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
85	Lebombo[109] (including "Nongoma graben" and Natal trough in S)	31°E and 32°E, 22°30′S and 27°S	N-S, NE-SW in S	600	60	Late Carboniferous–Early Permian	k423?, g4? k421? g1?	Haughton (1963), Christie and Tavener-Smith (1979), Whateley (1979), Hobday (1982), Daly et al. (1989), Veevers et al. (1994)
86a	Ruhuhu	35°E, 10°S	NE-SW	120	80	Stephanian	k423?, g1?	Veevers et al. (1994), Schlüter (1997)
86b	Ruhuhu (reactivated)	35°E and 36°30′E, 9°30′S and 10°30′S	ENE-WSW	200	>50	late? Neogene	k5?, g1	Baker (1971), Pallister (1971)
87	Metangula-Ruvama-Luwegu-Selous rift	35°E and 39°E, 5°S and 12°S	NE-SW (in S) NNE-SSW (in N)	1000	<70 (in S) ~200 (in N)	Late Permian (latest Carboniferous)[110]	k423?, g1?	Coffin and Rabinowitz (1988), Wopfner and Kaaya (1991), Wopfner (1993), Veevers et al. (1994), Mbede and Dualeh (1997), Schlüter (1997)
88	Tanga	~39°E, 4°30′S and 6°30′S	NNE-SSW	150	30 (onshore) 90 (offshore)	latest Carboniferous? or middle Permian? Early Jurassic–Middle Jurassic reactivation	k423?, g2	Coffin and Rabinowitz (1988), Veevers et al. (1994), Mbede and Dualeh (1997), Schlüter (1997)
89	Mombasa-Lugh[111]	40°E, 5°N and 3°S	N-S, NNE-SSW in N	1200	400 (max at Chisimaio) 250 (at Lugh) <100 (at Mombasa)	Late Carboniferous Middle Jurassic–Early Cretaceous reactivation Paleocene–Eocene faulting and subsidence	k423?, g2, g3?	Peterson (1985), Coffin and Rabinowitz (1988), Bosellini (1989), Dualeh et al. (1990), Mbede and Dualeh (1997), Schlüter (1997)
90	Al Kufrah	20°E and 25°E, 14°N and 15°N	NW-SE to NNW-SSE (Paleozoic)[112] NNE-SSW (Mesozoic)	450 (Paleozoic avg) 700 (Mesozoic)	150? (Paleozoic avg; magnetic pattern gives 50) 150 (Mesozoic)	1. Cambrian 2. Permian? 3. Middle Jurassic?[113]	1. k32, g4 2. k32, g4 3. k32, g4	Klitzsch (1986, 1990), Bellini et al. (1991), Petters (1991, p. 484–486)
91	Tesoffi	0°15′W, 19°30′N	NNE-SSW	100	25 (max)	latest Precambrian–Early Cambrian	k32, g1	Boullier (1991, Fig. 9), Kampunzu and Popoff (1991)

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[109] An ill-defined Tugela trough seems to cut Natal trough in an E-W direction (see Hobday, 1982, Fig. 7).

[110] Latest Carboniferous rifting is surmised on the basis of seismic reflection data. Late Permian age based on *Lueckisporites* sp. and *Guttulapollenites hannonicus* (Schlüter, 1997, p. 160, and the references there). Coffin and Rabinowitz (1988, p. 12) mentioned (on the basis of Kent, 1982, p. 188?) "Carboniferous activation of systems of faults" in Tanzanian coastal basins (presumably the Tanga fault zone, the Selous rift, and the Lindi fault zone—see Mbede and Dualeh, 1997, Fig. 9) but cited no evidence.

[111] The Lugh basin is called the "Luug-Mandera basin" by Mbede and Dualeh (1997). We here adopt Bosellini's (1989) spelling.

[112] This trend, possibly related to the Najd trend in Arabia (cf. Şengör and Natal'in, 1996a), is expressed by alternating highs and lows in the magnetic basement under the Mesozoic Al Kufrah basin (Bellini et al., 1991). It is very likely related to en echelon Paleozoic basins illustrated by Klitzsch (1990) in the same area.

[113] During the limited time available to us for this compilation, we have been unable to review the numerous original descriptions of the Al Kufrah basin geology, which underwent a radical stratigraphic revision in 1986 by Klitzsch. The cited summaries, though valuable as guides to literature and as broad outlines, are not helpful for understanding the tectonic history and origin of the basin as a whole. Our assessment is based on our own interpretation of the summary stratigraphy and structure in the cited works.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Africa *(continued)*								
92	Erg-N-Ataram (two rifts side by side separated by one strike-slip fault)	2°E, 24°N	N-S	150 (W rift) 200 (E rift)	80 (W rift) 30 (E rift)	latest Precambrian–Early Cambrian	k32, g1	Boullier (1991, Fig. 9)
93	El Kharga–Atbara	30°E and 35°E, 15°N and 30°N	NNW-SSE	1330	120	latest Precambrian–Early Cambrian	k31?, g4 k32?, g4	Schandelmeier et al. (1987)
94	Dongola-Selima	28°E and 34°W, 14°N and 30°N	NNW-SSE	1700	220	latest Precambrian–Early Cambrian	k31?, g4 k32?, g4	Schandelmeier et al. (1987)
95	Eastern Desert rift	32°30′E and 33°30′E, 26°N and 28°45′N	NNW-SSE	220	50	Neoproterozoic (670–650)	k411 or k31, g1	Stern et al. (1984)
96	Gourma aulacogen	3°E and 0°30′E, 14°N and 15°N	E-W	370	10 (max)	Neoproterozoic (850–800)	k1, g2	Moussine-Pouchkine and Bertrand-Sarfati (1978), Caby (1987), Petters (1991, p. 292–293)
97	Gulf of Katanga	26°E and 30°E, 7°S and 11°S	NE-SW	500	320 (max)	Mesoproterozoic-Neoproterozoic boundary (initial rifting just before 1 Ga)	k1, g2	Mendelsohn (1981)
98	Ventersdorp	22°E and 29°E, 25°S and 31°S	NNE-SSW	800	200	Archean (2.64 Ga)	k421, g1	Burke et al. (1985)
Madagascar								
1	Diego (or Diego-Ambilobe)	48°E and 50°E, 12°S and 14°S	NE-SW	200	>60	middle Permian	k423?, g2, g3	Besairie (1971), Boast and Nairn (1982), Coffin and Rabinowitz (1988)
2	Majunga	46°E and 48°E, 14°S and 17°S	NE-SW	420	200	Late Permian	k423?, g2, g3	Besairie (1971), Boast and Nairn (1982), Coffin and Rabinowitz (1988)
3	Morondava	43°E and 45°30′E, 17°30′S and 25°S	N-S (general) NNW-SSE (N of 20°S) NNE-SSW (S of 20°S)	520	120	Late Carboniferous	k423?, g2, g3	Besairie (1971), Boast and Nairn (1982), Coffin and Rabinowitz (1988)
Australia and New Guinea[114]								
1	Goodenough Bay–Milne Bay–Dawson Strait	150°E, 10°S	E-W (all three)	~100 (each structure)	~15 (each structure)	Pliocene–Holocene	k22, g3	Taylor and Exon (1987)
2	Aru trough	134°E, 6°E	NNE-SSW	200	50	Pliocene	Extrados extension (unclear whether rift or just graben?)	Jacobson et al. (1979)

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[114] For taphrogeny in Australia in general see: Doutch and Nicholas (1978), Plumb (1979), Falvey and Mutter (1981), Palfreyman (1984), Veevers (1984), Veevers et al. (1991). For small Permian basins, controlled by normal faulting only to a small degree and that consequently cannot be properly termed rifts, see Wopfner (1980).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Australia and New Guinea *(continued)*								
3	Murray basin	140°E and 148°E, 32°S and 38°S	N-S rifts (mainly)	~60–100 (each rift)	~30–50 (each rift)	early Cenozoic	k1, g2 and g3	Veevers (1984), Lawrence and Abele (1988)
4	Queensland taphrogen	144°E and 155°E, 11°S and 25°S	NW-SE	2000	50–200 (individual rifts)	Late Cretaceous (90–66 Ma)	k411, g3	Davies et al. (1991), Veevers (1991)
5	South Australian basin taphrogen	120°E and 150°E, 33°S and 44°S	E-W NW-SE (in E)	2500	~100 (in W) 900 (in E)	Middle Jurassic–Late Jurassic Early Cretaceous–Eocene	k1, g2 and g3	Talwani et al. (1979), Veevers (1984)
5a	Gippsland basin	148°E, 38°S	E-W	160	60–80	Early Cretaceous	k1, g2	Veevers (1984), Etheridge (1986), Douglas (1988), Hocking et al. (1993)
5b	Bass Strait basin	145°E, 40°S	NW-SE	225	100	Early Cretaceous	k1, g2	Veevers (1984)
5c	Otway basin	135°E and 145°E, 35°S and 44°S	NW-SE	>1000	150 200 (max) 100 (min)	Early Cretaceous	k1, g3	Veevers (1984), Etheridge (1986), Benedek and Douglas (1993), Kenley (1993), Abele et al. (1993)
5d	Polda trough	134°E, 33°30′S	E-W	>300	<100	Middle Jurassic	k1, g2	Veevers (1984)
5e	Ceduna depocenter	124°E and 135°E, along ±35°S	E-W	1200	300	middle Late Jurassic–Early Cretaceous	k1, g2 and g3?	Talwani et al. (1979), Falvey and Mutter (1981), Veevers (1984)
5f	Bremer basin	125°30′E, 34°S	E-W	~200	~100	Middle Jurassic	k1, g2	Falvey and Mutter (1981), Veevers (1984)
6	Roebuck basin	117°E and 120°E, 15°S and 18°S	Equant, with some ENE-WSW elongation	300	300	Late Permian Late Triassic Middle Jurassic	k1 (Late Permian) k1, g2? (Triassic) k1, g3? (Jurassic)	AGSO North West Shelf Study Group (1994), Hocking et al. (1994)
7	Western Coastlands taphrogen	105°E and 117°E, 15°S and 35°S	N-S NW-SE (offshoots to the west)	1600	500	Early Ordovician (in N) Permian and Middle Jurassic	? (Ordovician) k32, g2 (Permian) d1? (Middle Jurassic)	Görür and Şengör (1992), Baillie et al. (1994), Hocking et al. (1994), Gorter et al. (1994)
7a	Perth basin	115°E and 117°E, 30°S and 35°S	N-S	500	250	Late Permian latest Triassic–Jurassic Early Cretaceous	k411 or k32 k1, g2? (Triassic) k1, g3? (Jurassic; uplift seems too narrow!) k411, g3 (Cretaceous)	Hocking et al. (1994), Exon and Colwell (1994), Mory and lasky (1994), Quaife et al. (1994)

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Australia and New Guinea *(continued)*								
7b	Caernarvon basin	105°E and 117°E, 15°S and 30°S	NE-SW (to N) N-S (middle) NW-SE (to S)	1200	500	Early Ordovician Permian Late Triassic–Early Jurassic Middle Jurassic Early Cretaceous	? (Ordovician) k32, g2 (Permian) k1, g2? (Triassic) k1, g3? (Jurassic; uplift seems too narrow!) k411, g3 (Cretaceous)	Görür and Şengör (1992), Hocking et al. (1994), Stagg and Colwell (1994), Exon and Colwell (1994), Warris (1994)
8	Bonaparte basin	126°E and 130°E, 10°S and 17°S	NNW-SSE (Paleozoic) ENE-WSW (Mesozoic)	600 (Paleozoic) 700 (Mesozoic)	Paleozoic: 300 (max) <100 (min) Mesozoic: 200	Late Devonian–Late Carboniferous Middle Jurassic	k1, g2 (Paleozoic) k1, g3 (Mesozoic)	Mory and Beere (1988), AGSO North West Shelf Study Group (1994), Baillie et al. (1994), Hocking et al. (1994)
9	Browse basin	121°E and 125°E, 12°S and 16°S	NE-SW	450	300	Late Devonian–Early Carboniferous Early Carboniferous–Early Permian Middle Jurassic	? (Late Devonian–Early Carboniferous) k411? (Early Permian) k1?, g3? (Middle Jurassic)	AGSO North West Shelf Study Group (1994), Hocking et al.(1994), Maung et al. (1994), Symonds et al. (1994)
10	Canning taphrogen[115]	119°E and 128°E, 16°S and 23°S	NW-SE	700	550	Early Ordovician–Early Carboniferous	k31?,g4	Purcell (1984), Yeates et al. (1984), Baillie et al. (1994)
10a	Gregory-Fitzroy basin	122°E and 128°E, 16°S and 22°S	NW-SE	700	300	Early Ordovician–Early Carboniferous	k31?,g4	Yeates et al. (1984), Baillie et al. (1994), Braun and Shaw (1998)
10b	Willara–Southwest Kidson subbasin	120°E and 125°E, 18°S and 23°S	NW-SE	700	100 (avg) 165 (max) 83 (min)	Early Ordovician–Silurian?	k31?, g4	Purcell (1984), Yeates et al. (1984), Baillie et al. (1994)
11	Adelaide	137°E and 140°E, 30°S and 35°S	N-S	~500	>200 (max) 100 (min)	Neoproterozoic (<840 to 600 Ma)	k1, g2?	von der Borch (1980), Preiss et al. (1981), Jago and Moore (1990)
12	Batten trough	135°E, 12°S and 18°S	N-S	700	100	pre–1450 Ma	k1?, g2?	Brown et al. (1968), Rutland (1976), Plumb (1979)

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[115] Probably a part of a much larger "Larapintine taphrogen" (from the Larapinta Group comprising Pacoota Sandstone, Horn Valley Formation, Stairway Sandstone, and Stokes Formation; see Brown et al., 1968, p. 56 and 84) including the Amadeus basin (see especially Baillie et al., 1994, Fig. 7D).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
New Zealand								
1	Central volcanic region (Taupo rift) (continues into Havre trough)	175°30′E and 177°E, 38°S and 40°S	25°	200	110 (max) 60 (min)	Pliocene	k411, g1	Suggate (1978a, 1978b [passim]), Stern (1987), Lamb (1988)
North America[116]								
1	Point Arena–Bodega–Pigeon Point–La Honda–Salinas basin complex	120W and 124W, 35°N and 40°N	NW-SE	800 150–300 (individual basins)	45 (avg)	late Miocene–Pliocene	k32, g1[117]	Blake et al. (1978), Graham (1979), Biddle (1991), Hall (1991, p. 20 ff), Atwater and Stock (1998)
2	Ridge basin	118W and 119W, 34°30′N and 34°50′N	NW-SE	80	25	late Miocene	k32, g1	Crowell and Link (1982), May et al. (1993)
3	Salton Sea trough	114W and 117W, 32°N[118] and 34°N	NW-SE	250	100 (max)	late Miocene	k32, g1	Crowell and Sylvester (1979), Elders (1979), Axen and Fletcher (1998)
4	Catalina basin[119]	118°30′W, 33°15′N	NW-SE	70	25 (avg)	middle Miocene	k32, g1	Blake et al. (1978), Christie-Blick and Biddle (1985), Luyendyk and Hornafius (1987), Fritsche (1998)
5	San Nicolas	119W, 32°45′N	NW-SE	70	30	middle Miocene	k32, g1	Blake et al. (1978), Christie-Blick and Biddle (1985), Luyendyk and Hornafius (1987), Fritsche (1998)
6	Rio Grande	100W and 108W, 28°N[120] and 41°30′N	N-S SSE-NNW (S of 33°N)	1300	100 (avg)	late Oligocene	k411, g4 k32, g4	Hawley (1978), Riecker (1979), Dickerson and Muehlberger (1985), Keller and Cather (1994), Russel and Snelson (1994a, 1994b), Stewart (1998), Campbell-Stone et al. (2000)
7	Basin and Range taphrogen	95W and 125W, 18°N and 49°N	N-S (in N half) NNW-SSE (in S half)	3500	800 (max)	earliest Eocene (in N) to late Miocene (in S)	k411, g4 k32, g4	Howard and John (1987), Stewart (1998)

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[116] For geologic evolution and taphrogeny in North America in general, see Stille (1940: very much out-of-date, yet still rewarding reading) and King (1977: though out-of-date in many details and especially with respect to the Cordillera, this remarkable book remains the best introduction to the tectonics of North America),

[117] Though Atwater and Stock's (1998) reconstruction makes these basins pull-aparts (and in part transtensional basins), the internal geometries of the basins are more complicated. The Bodega basin, for example, displays alternating normal and thrust faults in one cross section (Blake et al., Fig. 13), as is typical of many strike-slip fault strands with flower structures. Our identification of their "pull-apart" character is based in part on the overall kinematic evolution as deduced by Atwater and Stock (1998) and in part on our assessment of the preponderance of the kind of deformation (especially Blake et al., 1978; Graham, 1979). Such basins as Point Reyes Fault and Outer Santa Cruz, in close association with the basins we list in the table, are clearly compressional basins.

[118] As the Salton Sea trough is nothing more than the northern termination of the Gulf of California mini-ocean, its southern "boundary" is artificial. We arbitrarily took the sea-land limit as the boundary, and as the 32°N parallel passes just north of that limit, we employed it to define the Salton Sea trough rift to the south. Crowell (1987) used the 30°N parallel, well into the Gulf of California, as the southern limit.

[119] Both Catalina and San Nicolas basins are parts of the diffusely deforming California Borderland, which, as a whole, sits in a large pull-apart geometry (Atwater and Stock, 1998, Fig. 7; cf. especially Blake et al., 1978, Fig. 20). There are many other basins within the Borderland (e.g., Patton, Tanner, Santa Cruz, Santa Monica, San Diego trough), but their position vis-à-vis their bounding strike-slip systems do not suggest that they are now pull-apart basins (see Blake et al., 1978, Figs. 21 and 22; Christie-Blick and Biddle, 1985, Fig. 11C; Luyendyk and Hornafius, 1987, Fig. 11-8; also see the schematic diagram in Crowell, 1974, Fig. 12, which was clearly inspired by the California Borderland structure). The same is also true of the Los Angeles and Ventura basins (see the geohistory analyses of these basins in Dickinson et al. [1987] and Mayer [1987]). Basin geometries in California have changed rapidly in the past 20 Ma as Atwater and Stock's (1998) reconstructions—and very especially their beautifully executed computer animation (at http://www.geol.ucsb.edu/~atwater) –show. For a simple statement of the problem, see Fritsche (1998).

[120] This lower limit in Coahuila is the one conventionally accepted (cf. Stewart, 1998, Fig. 1). But the zone of extension and volcanism extends even farther to almost 17°N parallel (Robin, 1982). However, the rift morphology in the Mexican segment beyond Chihuahua is indistinct.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
North America *(continued)*								
8	Numic subtaphrogen[121]	111°W and 125°W, 35°N and 49°N	N-S	1600	800 (max) 350 (min) 600 (avg)	earliest Eocene (in N) to early Miocene (in S)	k411, g4 k32, g4	Becker (1934), Eaton (1982), Ingersoll (1982), Wernicke (1990, 1992), Jones et al. (1992), Stewart (1998), Wernicke and Snow (1998), Sonder and Jones (1999), Snow and Wernicke (2000), Wernicke et al. (2000), Dickinson (2001)
9	Southeastern Omineca (Omineca and Okanogan)	116°W and 120°W, 48°N and 52°N	0°	390	225	Eocene (58–47 Ma)	d2-k2-k42-g4[122]	Parrish et al. (1988, 1991)
10	St. George basin	164°W and 170°W, 56°N and 57°N	300°	200	28	late middle Eocene–early Oligocene	d2-k3-k31-g4	Worrall (1991), Herman (1998), Comer and Herman (1998)
11	Norton basin	163°W and 169°W, 63°N and 65°N	320°	150	75	late middle Eocene–Oligocene	d2-k3-k31-g4	Fisher et al. (1982), Helwig et al. (1984), Worrall (1991), Banet (1998), Herman (1998)
12	Navarin basin	173°W and 179°W, 57°N and 62°N	315°	250	25–100	late middle Eocene–Oligocene	d2-k3-k31-g4	Herman (1998), Worrall (1991)
13	Jones Sound basin	78°W and 86°W, 76°N	300°–280°	240	18–60	Cretaceous–earliest Oligocene	d1-k1	Okulitch and Trettin (1991)
14	Lancaster Sound basin	77°W and 87°W, 74°N	90°	360	60	Cretaceous–earliest Oligocene	d1-k1[123]	Trettin (1989), Okulitch and Trettin (1991), Balkwill et al. (1990)
15	Eclipse trough (Bylot Island basin)	77°W and 81°W, 72°N and 74°N	310°	180	12–60	Cretaceous (Albian–Cenomanian)–earliest Oligocene	d1-k1[124]	Trettin (1989), Okulitch and Trettin (1991), Balkwill et al. (1990)
16	Foxe and Baffin structural depression	74°W and 83°W, 66°N and 70°N	320°[125]	420	360	Cretaceous–earliest Oligocene	d1-k1[126]	Trettin (1989), Okulitch and Trettin (1991)
17	Lincoln Sea basin	30°W and 70°W, 83°N and 84°N	45°	350	>200	Late Cretaceous–Tertiary[127]	d2-k3-k32-g4	Haimila et al. (1990), Dawes (1990)

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[121] We introduce the term *Numic taphrogen* (or *subtaphrogen*) to cover that part of the North American middle to late Cenozoic Basin and Range province lying north of the bottleneck in the area of this style of deformation in northwestern Arizona and southeastern California (for the geology of the bottleneck region, see Faulds et al.,1990), Wernicke and Snow (1998), and esp. Snow and Wernicke (2000). The taphrogen thus spreads across the states of Oregon, southern Idaho, northeasternmost California, Nevada, western Utah, and northwesternmost Arizona. This territory is almost exactly coincident with the area of spread of the Numic Indian languages (approximately A.D. 1000 was the time of spreading of Numic Indian languages (approximately A.D. 1000 was the time of spreading of Numic-speaking tribes in this area), from which we have derived the name. The Numic and the Piman subtaphrogens (see the rift list of Central America including the Caribbean) together make up the Basin and Range taphrogen of North America (Stewart, 1998).

[122] Extension formed the metamorphic core complexes. Stretching lineations indicate a northwest-southeast direction of extension. Extension has been interpreted as a result of the gravitational collapse of crust that was overthickened during the Mesozoic–early Cenozoic compression (Parrish et al., 1991, 1988). On the other hand, Price and Carmichael (1986) argued that the Eocene extension accommodated the nonaligned dextral shear of the region. We think that plate-boundary forces probably have played a more dominant role in the origin of the metamorphic core complexes than body forces affecting the orogen.

[123] The Lancaster Sound basin is underlain by a thick succession of deformed, fault-controlled rocks. It may represent a Precambrian aulacogen that was reactivated during the Cretaceous-Cenozoic (Balkwill et al., 1990)

[124] Deep erosion preceded the formation of the basin.

[125] The basin is almost equidimensional. We give the trend of the bounding faults.

[126] The Eclipse trough, Lancaster Sound basin, Jones Sound basin, Cumberland Sound graben, Frobisher Bay graben, and the Hudson Strait graben are related to the opening of the Labrador Sea and the Baffin Bay.

[127] The Sverdrup Early Carboniferous–Early Permian extensional basin continues beneath thick (>8 km) Upper Cretaceous to Tertiary *sedimentary cover of the Lincoln Sea basin.*

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
North America *(continued)*								
18	Melville Bay graben[128]	52°W and 66°W, 68°N 76°N	0°–330°	920	70	Cretaceous–Tertiary[129]	k21	Keen et al. (1990), Balkwill et al. (1990)
19	Cumberland Sound graben	64°W and 66°W, 64°N and 66°N	320°	150	54	Cretaceous–Tertiary[130]	d1-k1	Balkwill et al. (1990)
20	Frobisher Bay graben	66°W and 67°W, 63°N and 64°N	325°	120	50	Cretaceous–Tertiary	d1-k1	Balkwill et al. (1990)
21	Hudson Strait graben	65°W and 69°W, 61°N	285°	280	150	Cretaceous–Tertiary	d1-k1	Balkwill et al. (1990)
22	Wandel Sea basin	15°W and 26°W, 82°N and 83°N	305°	300	60	Late Cretaceous–Tertiary	d2-k3-k32-g4	Dawes (1990), Haimila et al. (1990)
23	Saglek basin	60°W and 63°W, 59°N and 62°N	320°–0°	350	50–100	Early Cretaceous[131] and then early Late Cretaceous	k22	Keen et al. (1990), Balkwill et al. (1990)
24	Hopedale basin	55°W and 60°W, 55°N and 58°N	325°	500	150	Early Cretaceous (Hauterivian–early Cenomanian[132]) early Late Cretaceous	k21[133]	Keen and Beaumont (1990), Keen et al. (1990), Balkwill et al. (1990)
25	Mississippi embayment	98°W and 88°W, 34°N and 37°N	25°	400	175–325	middle Cenomanian–early Campanian[134]	k1[135]	Burke and Dewey (1973), Salvador (1991b)
26	Nuvuk basin	150°W and 158°W, 71°N and 72°N	290–325°	340	>30	Late Jurassic–Neocomian	k21	Grantz et al. (1990)
27	Dunkum graben	144°W and 150°W, 70°N and 71°N	290°	166	40	Late Jurassic–Neocomian	k21	Grantz et al. (1990)
28	Kugmallit trough	137°W and 132°W, 68°N and 70°N	30°	280	30–140	Late Jurassic–Neocomian	k21	Dixon and Dietrich (1990)
29	Big River subbasin	127°W and 125°W, 72°N and 73°N	55°	100	40	latest Jurassic–Early Cretaceous	k21	Dixon and Dietrich (1990)
30	Central Bank graben	122°W, 72°N and 74°N	0°	180	50?	latest Jurassic–Early Cretaceous	k21	Dixon and Dietrich (1990)

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[128] As a well-defined graben structure (400 km long and 50–75 km wide), it is defined only in the northwestern part of the structure that is indicated in the map (Balkwill et al., 1990). We adopted the Keen et al. (1990) geometry of the Melville graben.

[129] Normal faulting predates the early Tertiary basalts according to Balkwill et al. (1990).

[130] Extension in the Baffin Bay area occurred in two episodes. The first episode was Early Cretaceous, and the second one was Paleocene, synchronous with the opening of the bay (Balkwill et al., 1990).

[131] The Cretaceous history of the Saglek basin is very similar to the history of the Hopedale basin. The principal difference is the abundance of the Late Cretaceous, Paleocene, and Eocene tholeiitic basalts in the Saglek basin (Balkwill et al., 1990), which are related to the opening of the Baffin Bay.

[132] Berriasian–Hauterivian volcanism preceded the formation of grabens. The volcanism lasted till the Albian (Keen et al., 1990).

[133] Balkwill et al. (1990) documented wide erosion prior to and during the Cretaceous rifting.

[134] Tilting was accompanied by magmatic activity (100–80 Ma).

[135] The sharp middle Cenomanian unconformity indicates uplift of the region preceding the tilting and the magmatic activity.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
North America *(continued)*								
31	Carolina trough	78°W and 75°W, 32°N and 36°N	30°	570	40	Early Jurassic–early Middle Jurassic (195–175 Ma)	k21	Dillon and Popenoe (1988), Klitgord et al. (1988)
32	Blake Plateau and Bahamas[136] basins	77°W and 80°W, 25°N and 32°N	0°	615	300	Early Jurassic–early Middle Jurassic (195–171 Ma)[137]	k21	Dillon and Popenoe (1988), Sheridan et al. (1988), Sheridan (1989), Klitgord et al. (1988)
33	Orphan basin (East Newfoundland basin)	52°W 40°W, 48°N and 50°N	290°	450	400	Late Triassic–earliest Jurassic Late Jurassic–Early Cretaceous[138]	k22 (Late Triassic–earliest Jurassic) k21[139] (Late Jurassic–Early Cretaceous)	Keen and Beaumont (1990), Keen et al. (1990), Parson et al. (1985), Grant and McAlpine (1990)
34	Jeanne d'Arc basin	50°W and 48°W, 45°N and 47°N	35°	350	50–90	Late Triassic–Early Jurassic[140] latest Jurassic–Neocomian	k22 (first episode) k21 (second episode)	Keen et al. (1990), Grant and McAlpine (1990)
35	Whale basin	53°W and 51°W, 45°N and 46°N	65°	220	90	Late Triassic–Early Jurassic[141] latest Jurassic–Neocomian	k22 (first episode) k21[142] (second episode)	Keen et al. (1990), Grant and McAlpine (1990)
36	Orpheus graben (west) and South Whale basin (east)	61°W and 52°W, 43°N? and 46°N	90°–70°–315° (east to west)	730	30 (west) >200 (east)	Late Triassic–Early Jurassic[143]	k21	Keen and Beaumont (1990), Keen et al. (1990), Wade and MacLean (1990)

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[136] The Blake Plateau basin (north) and the Bahamas basin (south) are combined here. There are some differences between them, the most important of which is the absence of postrift Middle Jurassic deposits. Another important feature of the Bahamas basin is the post-Cretaceous faulting, which was caused by left-lateral shearing between the North American and the Caribbean plates (Sheridan et al., 1988).

[137] Early Jurassic mafic volcanism commenced when rifting had nearly ceased (Dillon and Popenoe, 1988). The basement of the basin contains a large proportion of mantle-derived intrusions.

[138] Rifting can be as old as late Jurassic (Parson et al., 1985). Grant and McAlpine (1990) infer two episodes of rifting: Late Triassic to earliest Jurassic and latest Jurassic to early Cretaceous.

[139] Lower Cretaceous sediments overlie the Paleozoic sediments. Keen et al. (1990) infer that a significant uplift was associated with the middle Cretaceous break-up that was followed by the Avalon break-up unconformity.

[140] This episode of rifting was followed by falcogenic development of the basin during the late early Jurassic and late Jurassic. In this respect, all rifts of the Grand Bank of Newfoundland are different from the shelf rifts to the southwest. Two episodes of mafic volcanism accompanied the rifting events: Triassic to early Jurassic and early Cretaceous (Grant and McAlpine, 1990). The Jeanne d'Arc basin has the same features.

[141] See the preceding footnote.

[142] In the Whale, Jeanne D'Arc, and Orphan basins, the late Jurassic to early Cretaceous rifting started with an uplift of the whole of the Grand Banks of the Newfoundland region (Avalon Uplift, Grant and McAlpine, 1990).

[143] In the rifts, dated sedimentary rocks are of Late Triassic age. However, Wade and MacLean (1990) inferred the presence of older Triassic and Permian beds. In the south, the rift is bounded by the Cobequid-Chedabucto strike-slip fault and therefore may have in part a transtensional origin (see Manspeizer and Cousminer [1988] for the pull-apart origin of the graben). In the southwestern part of the basin, there is an impact structure of Eocene age (Jansa and Pe-Piper, 1987).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
North America *(continued)*								
37	Scotian basin	68°W and 57°W, 40°N and 45°N	65°	1200	>200	Middle Triassic–Early Jurassic	k21	Keen and Beaumont (1990), Keen et al. (1990)[144], Wade and MacLean (1990)
38	Georges Bank basins	70°W and 67°W, 40°N and 43°N	40°	400	90–180	Late Triassic–Early to Middle Jurassic[145]	k22[146]	Schlee and Klitgord (1988), Keen et al. (1990), Wade and MacLean (1990)[147]
39	Fundy basin	68°W and 64°W, 43°N and 45°N	60°	400	100	Late Triassic–Early to Middle Jurassic[148]	k22[149]	Keen et al. (1990), Wade and MacLean (1990)
40	Baltimore Canyon trough	71°W and 75°W, 36°N and 40°N	0°–75°	615	60–100	Late Triassic–Early Jurassic	k22	Grow et al. (1988), Klitgord et al. (1988)
41	Hartford-Deerfield basin	73°W, 41°N 42°N	10°	175	25	Late Triassic–Early Jurassic	k21	Manspeizer and Cousminer (1988)
42	New York Bight and Long Island basins	72°E and 73°E, 40°N and 41°N	25°–25°	90 and 80	20 and 18	Late Triassic–Early Jurassic	k1, g4 and k1, g1[150]	Hutchison et al. (1986)
43	Newark-Gettysburg basins	74°W and 78°W, 39°N and 41°N	60°–90°	360	20–50	Late Triassic–Early Jurassic	k21[151]	Manspeizer and Cousminer (1988), Manspeizer et al. (1991)
44	Culpeper basin	77°W and 78°W, 38°N and 39°N	35°	166	20	Late Triassic–Early Jurassic	k21	Manspeizer and Cousminer (1988), Manspeizer et al. (1991)
45	Dan River and Danville basins	81°W and 79°W, 36°N and 37°N	50°	170	10	Late Triassic–Early Jurassic	k21	Manspeizer and Cousminer (1988)
46	Durham-Sanford-Wadesboro basin	81°W and 79°W, 35°N and 37°N	45°	235	20	Late Triassic–Early Jurassic	k21	Manspeizer and Cousminer (1988)
47	South Georgia rift (south) and Riddleville-Dunbarton-Florence basins	80°W and 87°W, 30°N and 34°N	55°	725	110–250	Late Triassic–Early Jurassic	—	Manspeizer et al. (1991), Salvador (1991a, 1991b)
48	Gulf of Mexico rifted margin	87°W and 99°W, 20°N and 33°N	10°–90°	1200	340–460	Late Triassic–Early Jurassic	k22	Worrall and Snelson (1989), Salvador (1991a, 1991b)
49	East Greenland graben cluster (offshore)	5°W and 17°W, 73°N and 83°N	20°	840	120–240	Paleozoic–Mesozoic	d1-k1-g3	Larsen (1990)
50	St. Anthony basin	52°W and 57°W, 50°N and 52°N	35°[152]	450	160–230	late Paleozoic[153]	—	Bell and Howie (1990)

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[144] Continental crust thins across the Scotian basin by a factor of two. However, there are only a few normal faults that may be related to this extension (Keen et al., 1990).

[145] Wade and MacLean (1990) stated that the post-breakup-unconformity rocks start with the upper Lower Jurassic. Magmatic events have been documented in the Early Cretaceous (Schlee and Klitgord, 1988).

[146] See Manspeizer and Cousminer (1988) for the pull-apart origin of the Georges Bank basins.

[147] Wade and MacLean (1990) inferred that rifting began in the Late Permian. They indicated that tholeiitic basalts erupted in the Early Jurassic. The same happened in the Fundy basin.

[148] The Triassic–Early Jurassic basalts formed during the late stage of rifting. Similar rocks have been identified in the southwestern part of the Scotian basin (Wade and MacLean, 1990).

[149] Manspeizer et al. (1991) inferred a transtensional origin for the Fundy basin related to the sinistral motion along the Cobequid-Chedabucto strike-slip fault.

[150] These rifts formed at the same time as the Baltimore Canyon trough and lie on the same trend. However, Manspeizer and Cousminer's (1988) model implies a pull-apart origin of these rifts that is related to the east-trending regional sinistral shear zone (N40-Kelvin lineament), bounding the rifts in the south. According to this model, the formation of the Georges Bank basins and Newark-Gettysburg basins is also relevant to displacement along this shear zone.

[151] Manspeizer et al. (1991) reported deep erosion of southern and central Appalachians before initiation of the Triassic–Early Jurassic grabens. They inferred a pull-apart origin of the Newark-Gettysburg basins as a result of sinistral motion along the east-striking N40-Kelvin lineament.

[152] Normal faults in the northern part of the basin have northwestern strikes (Bell and Howie, 1990).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
North America *(continued)*								
51	Magdalen basin	60°W and 63°W, 46°N 48°N	45°	330	90	late Paleozoic[154]	—	Keen et al. (1990), Bell and Howie (1990)
52	Sverdrup basin	60°W and 125°W, 75°N and 83°N	90°–45°	1600	400	Early Carboniferous–Early Permian[155]	d1-k1-g3	Trettin (1989), Beauchamp et al. (1994)
53	East Greenland rift basin (onshore)	17°W and 25°W, 70°N and 77°N	20°	780	120 (max) 30 (min)	Middle to Late Devonian Early Carboniferous–Early Permian Triassic–Middle Jurassic[156]	d1-k1-g3	Birkelund et al. (1981), Haimila et al. (1990)
54	Mead basin	158°W and 159°W, 69°N and 71°N	355°	120	40	Middle Devonian–Early Carboniferous	d2-k4-k41-k411-g3[157]	Anderson et al. (1994), Lane (1997)
55	Umiat basin	150°W and 155°W, 69°N	275°	200	50	Middle Devonian–Early Carboniferous	d2-k4-k41-k411-g3	Anderson et al. (1994), Lane (1997)
56	Narragansett basin	71°W, 41°N and 42°N	0–65°	200	55	Carboniferous	k32, g4	McMasre et al. (1980), Bradley (1982), Mosher (1983), Hatcher et al. (1989)
57	Moose River grabens	79°W and 84°W, 49°N and 52°N	55°–325° (convex to north)	630	100–140	Early Devonian Late Jurassic–Early Cretaceous	k1	Norris (1993)
58	Central Hudson grabens[158]	85°W and 90°W, 57°N and 61°N	330°	650	360	Early Silurian	k1	Norris (1993)
59	Evans Strait basin	84°W and 75°W, 63°N	90°	630	110	Early Silurian Cretaceous and/or post-Cretaceous	k1	Norris (1993)
60	Southampton basin	78°W and 85°W, 64°N and 68°N	315°	750	130 (max) 20 (min)	Early Silurian Cretaceous and/or post-Cretaceous	k1	Norris (1993)
61	Mississippi Valley graben (Reelfoot rift)	91°W and 88°W, 35°N and 37°N	50°	360	60 (max) 50 (min)	Early to Middle Cambrian[159]	k1	Ervin and McGinnis (1975), Kane et al. (1981), Braile et al. (1986), Denison (1989), Thomas (1989)

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[153] The history of the basin is very similar to the history of the Magdalen basin.

[154] Normal faults in the Magdalen basin are sealed by Pennsylvanian rocks (see Fig. 4.17 in Bell and Howie, 1990).

[155] Tholeiitic basalts and gabbroic to granitic intrusions in Ellesmere and Axel Heiberg islands as well as the Lower Cretaceous and the Cenomanian–Turonian unconformity are related to the extension that created the Canada basin (Trettin, 1989).

[156] Early Cenozoic basalt eruption within the East Greenland rift was related to the opening of the Atlantic Ocean (Karson and Brooks, 1999). Triassic rifting was concentrated in the southern segment of the East Greenland rift. Central and northern segments were affected by the Mesozoic extension only in the Middle Jurassic.

[157] Lane (1997) correlated extension within the Mead basin with the Middle to Late Devonian extension that created the south-facing continental margin of northern Alaska (Moore et al., 1994) and the opening of the Angayucham Ocean. Natal'in et al. (1999) presented evidence that this extension was related to the opening of a backarc basin that is located to the north of the Devonian–Early Carboniferous magmatic arc. This backarc basin is the equivalent of the Belkov-Tanatap basin in the Chukchi Sea shelf.

[158] Numerous small rifts and half rifts are located on both sides of a northwest-trending uplift, which is indicated in Figure 3.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
North America *(continued)*								
62	Rough Creek graben[160]	86°W and 89°W, 37°N	90°	210	50 (max) 10 (min)	end of Pre-cambrian–Early to Middle Cambrian	k1[161]	Collinson et al. (1988), Thomas (1989), Kolata and Nelson (1997)
63	Rome trough (Eastern Interior aulacogen)	85°W and 77°W, 37°N and 41°N	50°	650	100 (max) 60 (min)	Early–Cambrian–Early Ordovician	k1[162]	Ammerman and Keller (1979), Milici and Witt (1988), Rankin et al. (1989), Dart and Swolfs (1998)
64	Delaware aulacogen[163] (Tobosa basin)	102°W and 104°W, 30°N and 33°N	335°	300	70	Late Proterozoic–Cambrian	k1	Arbenz (1989), Denison (1989), Viele and Thomas (1989)
65	Oklahoma aulacogen[164]	96°W and 99°W, 34°N and 35°N	300°	325	50	Late Proterozoic–Cambrian[165]	k1[166]	Gilbert (1983), Denison (1989), Viele and Thomas (1989)
66	Ottawa-Bonnechere graben and Ottawa Embayment	72°W and 78°W, 45°N and 46°N	295°	420	50–110	Late Proterozoic–Cambrian[167]	k21, g1[168]	Rankin et al. (1989), Sanford (1993)
67	Tucson	110°W, 32°N	NE-SW	400	<100	Mesoproterozoic	k1?, g3?	Stewart (1972, 1976)
68	Aramagosa	116°W, 36°N	WNW-ESE	200	100	Mesoproterozoic	k1?, g3?	Wright et al.(1974)
69	Grand Canyon	112°W and 113°W, 36°N and 37°30′N	NW-SE	225	60 (avg)	Mesoproterozoic	k1, g3	Stewart (1972, 1976), Tonnsen (1986)
70	Four Corners	107°45′W and 110°W, 37°N	E-W	350	60 (avg)	Mesoproterozoic	k1, g3	Tonnsen (1986)
71	Belt basin (including Helena embayment)[169]	108°W and 118°W, 46°N and 49°N	NW-SE E-W (in Helena embayment)	800[170]	320 100 (in Helena embayment)	Mesoproterozoic (ca. 1500 Ma)	k1, g3	Ross, et al. (1963), Burchfiel and Davis (1975), Sears et al. (1982), Winston (1986), Burchfiel et al. (1992), Evans et al. (2000)

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[159] Burke and Dewey (1973) interpreted the Mississippi embayment as a failed rift arm that originated in the Mesozoic. Older extensional structures have subsequently been inferred in the region. These constitute what is called the Mississippi Valley rift or the Reelfoot rift. In reality, the latter two are also distinct.

[160] The Mississippi Valley rift and the Rough Creek rift together form the New Madrid rift complex (Braile et al., 1986).

[161] Before the rift origination, the Precambrian surface of the Illinois basin had a ragged topography with 240 m of relief, and the Precambrian rocks were deeply eroded.

[162] A regional uplift and regression of the Cambrian Sea preceded the formation of the Rome trough (Milici and Witt, 1988).

[163] The Delaware aulacogen is a poorly studied structure, which was inferred mainly on the basis of geophysical data. Structural trend and dimensions are very approximate and were taken from a very schematic figure of Denison (1989).

[164] Strong compressional deformation in the Carboniferous.

[165] Extension led to bimodal magmatism in the Late Proterozoic–Middle Cambrian (Gilbert, 1983).

[166] Before the Cambrian transgression, the region around the aulacogen was deeply eroded. Burke and Dewey (1973) interpreted the Mississippi rift, the Oklahoma aulacogen, and the Delawere aulacogen as failed arms of a triple junction. Thomas (1989) pointed out that the geologic record of the Mississippi rift differs from the record of the aulacogens. He interpreted the Oklahoma aulacogen as a leaky transform fault, and a propagating rift model may be inferred from his model for the Mississippi rift.

[167] The inference about the graben activity in the Cambrian is based on the existence of the alkalic ring complex 300 km west of Montreal of supposedly Cambrian age (Rankin et al., 1989). Early Cretaceous alkalic intrusions are exposed near Montreal in the eastern part of the Ottawa embayment (Sanford, 1993).

[168] Rankin et al. (1989) proposed a failed-arm model of a ridge-ridge-ridge triple junction for the origin of the Ottawa-Bonnechere graben. Biotite ^{40}Ar/^{39}Ar age dates of 790 Ma from metamorphic basement, indicating a paleodepth of 10 km, suggest considerable uplift and erosion of the basement prior to the Late Proterozoic opening of the Iapetus Ocean.

[169] Only the eastern end of the Helena embayment survives as a recognizable rift today. The rest has been destroyed by convergent tectonics. The Belt basin and the Moyie–Dibble Creek trough form two arms of a probable rift star.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
North America *(continued)*								
72	Moyie and Dibble Creek trough	110°W and 117°W, 49°N and 51°N	NE-SW	450	60	Mesoproterozoic	k1, g3	Kanasewich et al. (1968), McMechan (1981), Tonnsen (1986), Gabrielse and Yorath (1991)
73	Hornby basin	120°W and 124°W, 63°N and 68°N	35°	>450[171]	200	Mesoproterozoic (1700–1267 Ma)	d1-k1	Burke and Dewey (1973), Aitken and McMechan (1991)
74	Midcontinent rift system[172]	75°W and 98°W, 37°N and 42°N	Sinuous: NE-SW (E part) NNE-SSW (W part)	2000	55 (avg)	Mesoproterozoic (1110 to 1085)	k42, g3 but possibly k1, g3	Van Schmus and Hinze (1985), Gordon and Hempton (1986), Hinze et al. (1992, 1997), Klewin and Shirey (1992), Van Schmus (1992)
75	Seal Lake	64°W, 55°N	NNW-SSE	200	100 (avg)	Mesoproterozoic	k1?, g1?	Burke et al. (1978)
76	Baffin Island rift cluster	80°W, 72°N	WNW-ESE	300 (N rift) 180 (S rift)	170 (N rift) 50 (S rift)	Mesoproterozoic	k1?, g1?	Burke et al. (1978)
77	Thulean rifts	65°W, 78°N	WNW-ESE	100	50 (each of two rifts)	Mesoproterozoic	k1?, g1?	Burke et al. (1978)
78	Bathurst	105°W and 110°W, 64°N and 68°N	N-S	400	50 (avg)	Paleoproterozoic	k31 or k32, g1	Hoffman (1989)
79	Richmond Gulf	78°W, 57°30′N	E-W	170	~70	Paleoproterozoic	k1?, g3?	Stevenson (1968)
80	Cambrien Lake	70°W, 56°30′N	E-W	180	~50	Paleoproterozoic	k1?, g3?	Fahrig (1969), Dimroth et al. (1970)
Central America including the Caribbean[173]								
1	Port-au-Prince	72°18′W, 18°33′N	E-W	40	20 (max)	Holocene and older?	k32?, g1?	Mann and Burke (1984)
2	Unnamed, Cayman Ridge	76°W, 19°30′N	ENE-WSW	~50	~10	Holocene and older?	k32, g1	Mann and Burke (1984)
3	Windward Passage	73°45′W, 20°N	NNE-SSW	120	~20	Holocene and older?	k32, g1	Mann and Burke (1984)
4	Maimon	70°45′W, 18°50′N	NE-SW	10	1.5	Holocene and older?	k32, g1	Mann and Burke (1984)
5	Clonard	73°15′W, 18°30′N	E-W	50	10	Quaternary	k32?, g1?	Bowin (1975), Mann and Burke (1984)
6	Mirogoane Lakes	73°W, 18°30′N	E-W	40	~7	Quaternary	k32?, g1?	Bowin (1975), Mann and Burke (1984)
7	Montuosa	82°27′W, 7°45′N	WNW-ESE	40	15	late Pliocene	k32, g1 or k411, g1	Kolarsky and Mann (1995)
8	Cébaco basin complex	80°45′W and 81°45′W, 7°N and 7°45N	NE-SW	165	120	late Pliocene	k32, g1 or k411, g1	Kolarsky and Mann (1995)
9	Camp Perrin	73°35′W, 18°25′N	NW-SE?	20?	not available	Pliocene?	k32?, g1?	Mann and Burke (1984)

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[170] Not counting inferred arm west of Dillon block (see Winston, Fig. 1)

[171] The initial length of the aulacogen is unknown because it is now truncated in the southwest by the Mesozoic Mackenzie Mountains thrust front.

[172] Also referred to as Midcontinent gravity high, Midcontinent geophysical anomaly, and Central North American rift system.

[173] For geologic evolution and taphrogeny in Central America and the Caribbean in general, see Nairn and Stehli (1975), Mann and Burke (1984), Mascle (1985), Pindell (1985), Burke (1988), Pindell and Barrett (1990). For the evolution of ideas on the Caribbean, see Mattson (1977) for a not-altogether-satisfactory compendium.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Central America including the Caribbean ***(continued)***								
10	L'Asile	72°37′W, 18°32′N	ESE-WNW	~40	~10	Pliocene?	k32?, g1?	Mann and Burke (1984)
11	Navassa	75°30′W, 18°N	ENE-WSW	150	25	Pliocene	k32?, g1?	Mann and Burke (1984)
12	Yallahs	76°35′W and 76°45′W, 17°35′N and 17°55N	NNE-SSW	25	13	Pliocene	k32, g1	Burke (1967), Mann and Burke (1984, especially Fig. 6b4)
13	Sambu	78°30W, 8°20′N	NW-SE	110	30	Post–middle Miocene	k32, g1	Mann and Burke (1984), Mann and Kolarsky (1995)
14	Cauto	76°30′W, 19°N	E-W	110	50 (avg)	middle Miocene	k32?, g1	Mann and Burke (1984)
15	Low Layton	76°39′W, 18°48′N	E-W	~10	<5	Miocene	k32, g1	Burke et al. (1980), Mann and Burke (1984)
16	Pacaya[174]	90°36′W, 14°38′N	WNW-ESE	20	10	Miocene	k411, g1 (g2?)	Plafker (1976)
17	Ahuachapan[175]	89°49′W, 13°57′N	WNW-ESE	50 (N fault) 20 (S fault)	30	Miocene	k411, g1 (g2?)	Plafker (1976), Dengo (1985)
18	Lake Izabal	88°30′W and 90°W, 15°30′N and 15°45′N	ENE-WSW	125	20	Miocene	k32, g1	Plafker (1976), Dengo (1985)
19	Jocotán rift cluster (consists of at least two full rifts and four half rifts, see Plafker (1976, Fig. 1)	88°W and 90°W, 14°45′N and 15°45′N	NE-SW (individual rifts trend N-S to NNE-SSW)	200	20	Miocene	k32, g4	Plafker (1976), Dengo (1985)
20	Ulúa	88°W, 14°45′N and 15°30′N	N-S	90	30 (avg)	Miocene	k32, g1	Plafker (1976), Dengo (1985)
21	Ipala[176]	89°30′W and 89°45′W, 14°10′N and 14°50′N	N-S	60	25	Miocene	k32, g4	Plafker (1976), Dengo (1985)
22	Guatemala City	90°22′W, 14°38′N	NNE-SSW	30	10	Miocene	k32, g4	Plafker (1976), Dengo (1985)
23	Middle America Trench off Guatemala	89°30′W and 89°45′W, 14°10′N and 14°50′N	ENE-WSW	300?	100	Miocene[177]	k32, g1?	Aubouin et al. (1984)
24	Lake Nicaragua	84°W and 88°W, 10°N and 13°N	NW-SE	500	65	latest Oligocene	k411, g1, g3?	Dengo (1985), Thigpen (1976), Seyfried et al. (1987, 1991)
25	Sierra Madre Oriental[178]	97°W and 101°W, 26°N and 17°N	NNW-SSE	700	150	Oligocene	411, g2	Robin (1982)

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[174] We use the name of the volcano (from Simkin et al., 1981) to designate the rift in which the volcano sits and which is left nameless in our sources.

[175] We use the name of the city (from the 10th edition of the *Times Atlas of the World*) to designate the rift in which the city sits and which is left nameless in our sources.

[176] It seems to be part of a rift cluster with one full unnamed rift (graben?) some 25 km to its east and one large normal fault (half-rift?) 10 km to its northwest (see Plafker, 1976, Fig. 1).

[177] This age is based only on the late Senonian–Miocene age of the sequences dropped down into half grabens (cf. Aubouin et al., 1984, Fig. 1). We assume that the normal faulting disrupted a previously continuous upper Senonian–Miocene slope cover and was thus subsequent to its deposition. It so happens that a Miocene age is in harmony with the ages of the Guatemalan extensional arc rifts, showing that the entire arc, including the forearc, went into extension in the Miocene.

[178] This feature so neatly joins the Rio Grande rift in the United States, spatially and temporally, that it is difficult to resist the temptation to consider them both a single taphrogenic structure. In the Rio Grande rift, the age of rifting migrates northward (cf. Stewart, 1998), whereas in the Sierra Madre Oriental, the age of alkalic volcanicity migrates southward. This is a temporal pattern paralleled roughly by the behavior of the much larger Piman and Numic taphrogen pair to the immediate west (see the next footnote).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Central America including the Caribbean *(continued)*								
26	Piman subtaphrogen[179]	100°W and 115°W, 20°N and 34°N	NNW-SSE to NNE-SSW	2100	800[180]	Oligocene	411, g4 k31, g4 k32, g4	de Cserna (1975), Stewart (1998)
27	Anegada basin complex	63°45′W, 18°N	ENE-WSW	130	~20	post-Eocene	k32, g1	Mann and Burke (1984)
South America[181,182]								
1	Rancheria	73°30′W, 12°30′N	NE-SW	75	40	?–Holocene	k32, g1	Mann and Burke (1984)
2	Lake Valencia	67°30′W, 10°15′N	E-W	175	20	Pleistocene	k32, g1	Schubert (1981), Mann and Burke (1984)
3	Cordillera Blanca(?)	77°W and 78°W, 8°30′S and 10°S	NNW-SSE	170	10 (max)	Pliocene–Quaternary	k411?, g1 or k31[183]	Aubouin et al. (1973), Dalmayrac and Molnar (1981), Sébrier et al. (1988), Mercier et al. (1992)
4	Cuzco-Vilcanota fault system(?) (including Andahuaylas fault and basin)	71°W and 73°30′W, 13°15′S and 14°30S	Sinuous: E-W (in N) NW-SE (in middle) WNW-ESE (in S)	350	12 (max, at Cuzco) Generally much less	Pliocene–Quaternary	k411?, g1 or k31 and k32	Cabrera et al. (1987, 1991), Sébrier et al. (1988), Mercier et al. (1992)
5	Quito Interandean depression ("Intramontane rift valley")(?)	77°30′W and 79°30′W, 1°S and 3°30′S	NNE-SSW	250	30	Pliocene–Quaternary	k413?,g3 or k32?, g3[184]	Kennerley (1980), Daly (1989)

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[179] We introduce this name to denote the wide area of middle to late Cenozoic (dominantly 30–6 Ma) basin-and-range–style rifting extending from southwest Arizona to the east-trending Mexican volcanic belt (Robin, 1982) (or the Trans-Mexican volcanic chain of Dengo [1985] or the Neovolcanic Plateau of Raisz [1959]). The concept embraces Baja California, the Buried Ranges (extending into Arizona), basins and ranges, and the Central Mesa geomorphologic provinces of Raisz (1959, reproduced in de Cserna,1975, Fig. 1). The name was taken from the Piman branch of the Uto-Aztecan–speaking peoples. Now considerably reduced in numbers, they still live both in the Mexican state of Sonora and, in greater numbers, in the neighboring U.S. state of Arizona.

The Piman subtaphrogen is separated from the Numic subtaphrogen (see the North American rift list) in the north by the bottleneck in the area of basin-and-range–style faulting in northwestern Arizona and southeastern California (for the geology of the bottleneck region, see Faulds et al., 1990; Snow and Wernicke, 2000). Actually the Piman and the Numic subtaphrogens are the two main subtaphrogens of the immense basin-and-range taphrogen of North America extending from southwesternmost Canada to middle Mexico (Stewart, 1998).

[180] The width of the Gulf of California excluded.

[181] It is regrettable that no convenient modern handbook of South American geology exists. The only one of its kind that we are aware of, that by Jenks (1956), is nearly half a century old and is not useful to search for rifts in South America. Zeil's (1986) much newer attempt is both too brief and too schematic to be useful for the student of rifts. Stille's (1940) great classic can still be consulted with profit, though it is advisable to double check on it wherever possible. Fairbridge (1975), though aged considerably, is still the only one-volume compendium from which usable information pertaining to rifts in South America may be gathered.

[182] A number of extensional basins are depicted in the Sierras Pampeanas region by Aubouin and Borrello (1970, foldout plate). This interpretation is incorrect. The depicted basins are compressional structures associated with the Sierras Pampeanas shortening (see Jordan et al., 1983, Fig. 4b), i.e., they are ramp-valley basins and not rift-valley basins.

[183] The k31 type of rift (transtension along the Andean crestal region) is our preferred interpretation for the mode of rifting here. This interpretation is also supported by local seismicity (e.g., Deverchère, 1988).

[184] This is an extremely difficult extensional structure to classify, mainly because we have not had access to detailed maps of its border faults and to its geophysics. Most border faults are covered by young lavas anyway. It would have been an easy way out to call it a graben formed by spreading of the mountain welt, had we not had misgivings about the spreading model. For the time being, we favor Daly's (1989, Fig. 14) model of pull-apart origin.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
South America *(continued)*								
6	Santa Lucia	66°15′W, 10°25′N	E-W	40	<10	Pliocene	k32, g1 (Mann and Burke called it a "fault-wedge" basin)	Mann and Burke (1984)
7	Guarenas	66°15′W, 10°35′N	E-W	50	20	Pliocene	k32, g1	Mann and Burke (1984)
8	northern Peru (Namora–San Marcos–Cajabamba fault system)(?)	78°W, 7°20′S (centered on San Marcos basin)	Concave to SW: ESE-WNW (in N—Namora basin) NW-SE (in San Marcos basin) NNW-SSE (in S—Cajabamba basin)	95	11 (max in San Marcos basin)	early? Miocene	k411?, g1 or k31 and k32	Mercier et al. (1992)
9	Pampa del Tamarugal	70°W, 18°S and 27°S	N-S	900	50 (avg) 225 (between Salar de Atacama and Salar Mar Muerto)[185]	Miocene (initial faulting) Pliocene–Quaternary (main faulting)	k31, g3	Stille (1940, p. 536–539), Hartley et al. (1988), Allmendinger et al. (1989)
10	San Felipe[186]	68°W and 69°W, 10°N and 10°30′N	ENE-WSW	125	20	late Cenozoic	k32, g1	Schubert (1982a)
11	Ancon	70°W and 71°30′W, 10°50′N	E-W	150	25 (max)	Oligocene–Miocene	k32, g3	Muessig (1984)
12	Urumaco	70°30′W and 71°W, 10°45′N and 12°N	NW-SE	200	50	Oligocene–Miocene	k32, g3	Muessig (1984)
13	Falcón	68°15′W and 70°W, 10°45′N and 11°30′N	E-W	150	100 (max)	Oligocene–Miocene	k32, g3	Silver et al. (1975), Biju-Duval et al. (1982), Mann and Burke (1984), Muessig (1984), Boesi and Goddard (1991)
14	Gulf of Triste	66°45′W and 68°15′W, 10°40′N	E-W	180	40	Oligocene–Miocene	k32, g3	Silver et al. (1975), Biju-Duval et al. (1982), Muessig (1984)
15	Cariaco Trench	64°W and 65°50′W, 10°40′N	E-W	130	30	Oligocene–Miocene	k32, g3	Biju-Duval et al. (1982), Schubert (1982b), Mann and Burke (1984), Muessig (1984)
16	Chichibacoa basin	70°45′W and 71°30′W, 12°N and 12°45′N	NW-SE	100	35	Oligocene–Miocene	k32, g3	Muessig (1984)
17	Los Monjes	69°45′W and 70°50′W, 12°N and 12°50′N	NW-SE	70	70	Oligocene–Miocene	k32, g3	Muessig (1984)
18	Aruba	69°10′W and 70°W, 12°N and 12°50′N	NW-SE	130	40	Oligocene–Miocene	k32, g3	Silver et al. (1975), Biju-Duval et al. (1982), Muessig (1984)

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[185] This is the classical area of Walther Penck's Groβfaltung (grand folding), where Penck misidentified extensional structures as compressional structures (Penck, 1920) exactly as he had earlier done in western Turkey (Penck, 1918). For examples of the misleading effects of his work, see Stille (1919, p. 203–205; 1924, p. 31–34).

[186] We took this name from the nearest town shown on Schubert's (1982a, Fig. 1) map.

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
South America ***(continued)***								
19	Curaçao	68°20′W and 69°W, 12°N and 12°25′N	NW-SE	80	40	Oligocene–Miocene	k32, g3	Silver et al. (1975), Biju-Duval et al. (1982), Muessig (1984)
20	Las Aves	67°50′W and 68°20′W, 12°N and 12°25′N	NW-SE	100	40	Oligocene–Miocene	k32, g3	Silver et al. (1975), Biju-Duval et al. (1982), Muessig (1984)
21	Los Roques (N)	66°25′W and 67°50′W, 12°35′N	ESE-WNW	160	20	Oligocene–Miocene	k32, g3	Biju-Duval et al. (1982), Mann and Burke (1984), Muessig (1984)
22	Los Roques (S)	67°W and 67°40′W, 11°50′N and 12°25N	NW-SE	100	30	Oligocene–Miocene	k32, g3	Silver et al. (1975), Biju-Duval et al. (1982), Muessig (1984)
23	Bonaire	65°W and 69°W, 11°N and 12°N	E-W	350	115	Oligocene–Miocene	k32, g3	Silver et al. (1975), Biju-Duval et al. (1982), Mann and Burke (1984), Muessig (1984)
24	La Orchila basin	64°30′W and 65°45W, 10°45N and 11°20′N	NNW-SSE	200	50	Oligocene–Miocene	k32, g3	Mann and Burke (1984), Muessig (1984)
25	Lima(?)	77°W and 79°30′W, 10°S and 14°30′S	NW-SE	550	70	Oligocene and later	k411, g1 (extensional arc–trench gap basin)	Hussong and Wipperman (1981), Thornburg and Kulm (1981), von Huene (1990)
26	Salaverry basin(?)	78°W and 80°W, 7°S and 11°30′S	NW-SE	550	100	Oligocene and later[187]	k411, g1 (extensional arc-trench gap basin)	Travis et al. (1976), Hussong and Wipperman (1981), Thornburg and Kulm (1981), von Huene (1990)
27	Arequipa(?)	71°15′W and 72°30′W, 17°15′S and 18°30′S	NW-SE	150	50 (avg)	Oligocene and later	k411, g1 (extensional arc-trench gap basin)	Coulbourn (1981), Johnson and Ness (1981)
28	Arica(?)	70°30′W and 71°30′W, 18°10′S and 19°30′S	N-S	130	50 (max)	Oligocene and later	k411, g1 (extensional arc-trench gap basin)	Coulbourn (1981)
29	Iquique(?)	70°15′W and 70°45′W, 19°30′S and 20°45′S	N-S	120	20	Oligocene and later	k411, g1 (extensional arc-trench gap basin)	Coulbourn (1981)
30	Southern Trinidad	61°30′W, 10°15′N	E-W	50	25	Oligocene	k32, g1 (Mann and Burke classified it as k31, g3)	Bane and Chanpong (1980), Mann and Burke (1984)
31	Caroni	61°30′W, 10°30′N	E-W	50	20	Oligocene	k32, g1 (Mann and Burke classified it as k31, g3)	Mann and Burke (1984)

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[187] Normal faulting appears to have ceased in the Quaternary (see the profiles in von Huene, 1990). This makes the Cordillera Blanca extension a little bit easier to understand, for otherwise, half of the Peruvian Andes as far east as the volcanic axis would have been in extension (except at the toe of the accretionary complex northeast of the trench), while the other half would have been in compression. In any case, it seems that not only the highest regions have been sites of extensional deformation as claimed by Dalmayrac and Molnar (1981).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
South America *(continued)*								
32	Ayacara basin[188]	73°W, 42°S and 43°S	N-S (NNW-SSE?)	>160	?60	post-Eocene?	k32, g1	Rojas et al. (1994)
33	Progreso (including Esperanza and Jambeli basins and Playas uplift)	81°W, 3°S	E-W to ENE-WSW	160	150 (avg)	middle Eocene	k32, g1	Travis et al. (1976), Shepherd and Moberly (1981), Daly (1989), Pindell and Barrett (1990)
34	Sechura-Talara	80°W and 81°W, 4°30′S and 7°S	N-S (Sechura) NNW-SSE (Talara)	510	170	Paleocene (in Talara) post–Eocene (in Sechura)	k411, g3	Travis et al. (1976), Dalmayrac et al. (1980, p. 402–403)
35	Barreirinhas (including Sãn Luis)	40°W and 46°W, 1°S and 2°30′S	WNW-ESE	700	75–170	middle Albian	k32, g3	Asmus and Ponte (1973), Kumar et al. (1976), Zalan et al. (1985)
36	Oran (or Noroeste)[189]	61°W and 67°30′W, 20°S and 27°S	NNE-SSW to ENE-WSW (E branch) NW-SE in S, N-S in N (W branch)	800 (W branch) 800 (E branch)	100 (max, E branch) 150 (min, W branch)	Early Cretaceous	k1, g2	Uliana et al. (1989), Yrigoyen (1990)
37	Salinas Grandes	64°W and 65°30′W, 28°S and 30°S	N-S	~250	100	Early Cretaceous	k1, g2	Uliana et al. (1989), Yrigoyen (1990)
38	Jequitinhonha	38°W and 39°15′W, 15°S and 17°S	NNE-SSW	200	50 (max)[190]	latest Jurassic?	k1, g2	Asmus and Ponte (1973), Chang et al. (1992)
39	Pelotas	48°W and 54°W, 30°S and 34°S	NE-SW	800	200	Early Cretaceous[191]	k1, g2	Asmus and Ponte (1973), Urien et al. (1976), Campos et al. (1974), Ponte and Asmus (1976), Chang et al. (1992)
40	Espírito Santo	38°30′W and 40°W, 17°S and 20°S	NNE-SSW (general) ENE-WSW (two subbasins)	350	100 (max)	Early Cretaceous[192]	k1, g2	Asmus and Ponte (1973), Campos et al. (1974), Ponte and Asmus (1976), Chang et al. (1992)
41	Canelones "graben" (or Sta. Lucia)	56°W and 34°S	ENE-WSW	500	60 (max) 50 (min)	Late Jurassic (initial faulting) Early Cretaceous (main rifting)	k1?, g2? k33?, g1?	Urien and Zambrano (1973), Burke (1976), Urien et al. (1976), Emery and Uchupi (1984, Fig. 275), Uliana et al. (1989)
42	Sergipe and Alagoas	35°W and 37°15′W, 8°30′S and 11°30′S	NE-SW (with many subordinate N-S structures)	350	50	latest Jurassic[193]	k1, g2	Asmus and Ponte (1973), Campos et al. (1974), Ponte and Asmus (1976), Milani et al. (1988), Chang et al. (1992)
43	Campos	40°W and 41°W, 21°S and 23°S	NE-SW	250	140 (max)	latest Jurassic	k1, g2	Bacoccoli et al. (1980), Guardado et al. (1989), Mohriak et al. (1989), Chang et al. (1992)

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[188] We give this name to this basin after the Eocene–Miocene clastic and volcaniclastic Ayacara Formation that mostly fills it (cf. Rojas et al., 1994). The basin seems almost co-extensive with the Golfo de Corcovado.

[189] This is a complex basin formed from the meeting of three three-armed rift stars in northernmost Argentina in the earliest Cretaceous. See Uliana et al. (1989, Fig. 11) for a sketch map outlining it and some of the major fault systems within it. Uliana et al. (1989, p. 609) stated that it crowned a major pre-Cretaceous dome.

[190] Except at Royal Charlotte Bank, which is basaltic.

[191] To be specific, time of deposition of Buracica–Jiquilá sequence, i.e., Neocomian—but see Chang et al. (1993): time of deposition of Dom João sequence, no evaporite.

[192] To be specific, time of deposition of Rio de Serra–Jiquilá sequence and Dom João sequence(?); see Chang et al. (1993).

[193] The basin contains Permian–Triassic and Jurassic sedimentary rocks belonging to the Igreja Nova Subgroup. These rocks also extend outside the rift basin and do not constitute the rift fill. They are a part of the basement (see Asmus and Ponte, 1973, p. 97–98).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
South America *(continued)*								
44	Santos	43°W and 48°W, 23°30′S and 27°S	NE-SW	600	130	latest Jurassic	k1, g2	Asmus and Ponte (1973), Campos et al. (1974), Ponte and Asmus (1976), Soares and Landim (1976), Chang et al. (1992)
45	Recôncavo-Tucano-Jatoba	37°W and 39°W, 8°S and 13°S	N-S to 9°S (Recôncavo and Tucano basins) ENE-WSW (Jatoba basin N of 9°S)	650	50 (in S) 100 (in N except Jatoba) 50 (in Jatoba)	Late Jurassic	k1, g2	Asmus and Ponte (1973), Milani et al. (1988), Kingston and Matzko (1995)
46	Salado (or Rio Salado)	54°W and 61°W, 34°S and 38°S	NW-SE	880	200	Late Jurassic	k1, g2 k33, g1 (for the SE subbasin)	Urien and Zambrano (1973), Burke (1976), Urien et al. (1976), Uliana and Biddle (1988), Uliana et al. (1989), Yrigoyen (1990)
47	Laboulaye	63°30′W and 65°W, 33°S and 35°30′S	N-S	300	150 (max)	Late Jurassic	k1, g2	Urien and Zambrano (1973), Urien et al. (1976), Uliana and Biddle (1988), Uliana et al. (1989), Yrigoyen (1990)
48	Macachin	63°30′W, 35°30′S and 37°S	NNW-SSE	250	75	Late Jurassic	k1, g2	Urien and Zambrano (1973), Urien et al. (1976), Uliana and Biddle (1988), Uliana et al. (1989), Yrigoyen (1990)
49	Colorado	56°W and 64°W, 38°S and 40°S	WNW-ESE	700	170	Late Jurassic	k1, g2	Urien and Zambrano (1973), Burke (1976), Urien et al. (1976), Ludwig et al. (1979), Uliana and Biddle (1987, 1988), Uliana et al. (1989), Yrigoyen (1990)
50	Valdez	63°30′W, 42°30′S	NNW-SSE	200	<100	latest middle Jurassic–Late Jurassic (Early Jurassic?)	k33, g1	Urien et al. (1976), Uliana and Biddle (1987, 1988), Uliana et al. (1989)
51	Rawson	62°W, 41°S and 44°S	N-S	300	80	Middle Jurassic (also "Mesozoic")	k33, g1	Uliana and Biddle (1987, 1988), Uliana et al. (1989)
52	Malvinas Norte	58°W and 62°W, 47°S and 50°S	N-S (general) NE-SW (in N) NW-SE (in S)	400	300	Middle Jurassic	k32, g4	Urien et al. (1976), Uliana et al. (1989), Yrigoyen (1990)
53	Falkland Spur basins	45°W and 60°W, 48°S and 52°S	NW-SE (some six rifts)	<100 (each)	300–350 (avg)	Middle Jurassic	k32, g4	Rabinowitz et al. (1976), Uliana et al. (1989), Biddle et al. (1996)
54	Espino[194]	66°45′W and 61°W, 8°N and 9°30′N	NE-SW	220[195]	100	Bathonian? (or early to middle Mesozoic)	k1, g1? (g2?)	Feo-Codecido et al. (1984)
55	Tacutu "third arm"	57°W and 59°W, 4°N and 6°N	NE-SW	270	40	latest? Liassic	k1, g2?	Burke (1976), Walrond (1980)
56	Tacutu (or Takatu)	58°30′W and 61°W, 2°30′N and 4°N	ENE-WSW	330	25–40	latest Liassic	k1, g2?	Burke (1976), Walrond (1980), Kingston and Matzko (1995)

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[194] At least five other Jurassic rift basins to the west of Espino, namely, the Valledupar, Perija, Machiques, Uribante, and San Lazaro, probably formed at the same time and within the same taphrogen as the Espino basin, in all of which the Jurassic La Quinto Formation was deposited (e.g., Maze, 1984). They correspond with Burke's (1976, Fig. 1) "Maracaibo rift." We do not include them here, however, owing to strong compressional deformation that later obliterated their rift geometry (e.g., Kellogg, 1984).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
South America *(continued)*								
57	San Jorge	66°W and 71°W, 45°S and 47°S	E-W to ENE-WSW (between 66°E and 69°30′E) NE-SW (E of 69°30′E)	390	~130	Liassic (some inherited Late Triassic basin-forming structures?)	k1, g2	Urien et al. (1976), Uliana and Biddle (1988), Uliana et al. (1989), Fitzgerald et al. (1990), Yrigoyen (1990)
58	Arauco	73°W, 34°30′S and 38°S	N-S, with W boundary faults striking NNW-SSE	400	110	Late Triassic–Early Jurassic	k411, g3	Uliana and Biddle (1987, 1988), Uliana et al. (1989)
59	Neuquen	66°W and 72°W, 36°S and 40°S	NW-SE	600	150 (max) 75 (min)	Triassic–Jurassic	k411, g3	Urien and Zambrano (1973), Urien et al. (1976), Uliana and Biddle (1988), Uliana et al. (1989), Yrigoyen (1990)
60	Magallanes	68°W and 72°W, 48°S and 53°S	N-S to NNW-SSE	600 (two rifts en echelon, each ~300)	70 (avg)	Late?[196] Triassic	k411, g3	Urien et al. (1976), Gust et al. (1985), Biddle et al. (1986), Uliana et al. (1989), Yrigoyen (1990)
61	Nirihuau	71°30′W, 39°S and 44°S	N-S	~300	~100	Middle Triassic	k411, g3	Urien and Zambrano (1973), Uliana and Biddle (1987, 1988), Uliana et al. (1989)
62	Ternera[197]	70°W, 24°S and 29°S	N-S (E branch) NW-SE (W branch)	500 (E branch) 200 (W branch)	~60 (max) ~50 (min)	Early Triassic?	k411, g3	Muñoz Cristi (1956), Uliana and Biddle (1988), Uliana et al. (1989)
63	Alto del Carmen	70°W, 28°S and 30°30′S	NNW-SSE	300	100	Early Triassic?	k411, g3	Muñoz Cristi (1956), Uliana and Biddle (1988), Uliana et al. (1989)
64	Cuyo (including Atuel and San Luis)[198]	66°W and 70°W, 46°S and 50°S	N15°W (E arm) N30°W (W arm)	550 (E arm) 550 (W arm)	30 (E arm) 75 (W arm)	Early Triassic	k411, g3	Urien et al. (1976), Uliana and Biddle (1988), Uliana et al. (1989), Yrigoyen (1990)
65	Deseado	68°W and 71°W, 29°S and 36°S	NNW-SSE	750	50	Early Triassic	k411, g3	Uliana and Biddle (1988), Uliana et al. (1989)
66	Malvinas	62°W and 76°W, 50°S and 53°30′S	NW-SE (Triassic and Early Jurassic) NE-SW (Late Jurassic)	600	100 (Triassic) 300 (Early Jurassic) 200 (Late Jurassic)	Late Triassic	k411, g3	Urien and Zambrano (1973), Urien et al. (1976), Uliana et al. (1989)

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[195] May have originally extended beyond the Urica fault to east-southeast for another 150 km.

[196] The query results from our ignorance of the ages of layered rocks beneath the Tobífera Formation. They are dated as Late Triassic and Early Jurassic by analogy with similar sequences in the Andes (cf. Biddle et al., 1986, p. 46).

[197] We have associated these names of coal basins in Muñoz Cristi (1956) with the Triassic basins shown at appropriate places in Uliana et al. (1989, Fig. 2), because we have failed to find a source giving the names of those basins. We also assigned them an Early Triassic age and not a Late Triassic–Early Jurassic age as in Uliana et al. (1989, Fig. 2), because of the description of their contents by Muñoz Cristi (1956) and because they are exactly on strike with the western and eastern arms of the Cuyo basin. Early Mesozoic basin building in southern South America progressed generally from northwest to southeast and south (see also Bergmann and Xicoy, 1990, Fig. 1).

[198] What we designate herein as the east arm, the Argentine Petroleum Institute (1987) has called the "San Luis basin." Urien and Zambrano (1973) have called the south part of the west arm "Atuel" and the north part "Cuyo." The west arm as a whole is called "Cuyana" by the Argentine Petroleum Institute (1987).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
South America *(continued)*								
67	Amazon	50°W and 62°W, 0° and 5°S	E-W to ENE-WSW	1000 (more? 1600)	110	pre-Ordovician (estimated Late Cambrian)	k421, g1 (g2?)	Mosmann et al. (1986), Grabert (1991), Burke and Lytwyn (1994), Zoback and Richardson (1996)
68	Roraima	59°W and 61°30′W, 4°15′N and 6°45′N[199]	?NW-SE	?330	?110	Mesoproterozoic (>1536 Ma)	k1?, g1? or g2?	Walrond (1980)
Antarctica[200]								
1	Larsen	56°W and 63°W, 63°S and 66°30′S	NE-SW	300	50	Pliocene	k411, g3	Gonzáles-Ferrán (1983a, 1983b)
2	Prince Gustav	56°W, 63°S	NE-SW	100	<50	Pliocene	k411, g3	Tokarski (1991)
3	Bransfield basin	52°30′°W and 60°W, 62°S and 64°S	NE-SW	400	50	Pliocene	k411, g3	Tectonic Map of the Scotia Arc (1985), Anderson (1991), Gonzáles-Ferrán (1991), Guterch et al. (1991), Jeffers et al. (1991)
4	King George VI Sound	75°W and 70°W, 70°S and 73°S	NE-SW	500	75 (max) 0 (min)	Late Cretaceous–Cenozoic	k411, g3	Maslanyj (1991), Nell and Storey (1991)
5	West Antarctic taphrogen	160°E and 30°W, 70°S and 85°S	NNE-SSW (in Ross Sea) E-W (farther W)	>3000	800	middle Cretaceous to Neogene inclusive	k31,g4	Gonzáles-Ferrán (1982), Laudon (1982), Brewer and Clarkson (1991), Lawver et al. (1991), Le Masurier and Rex (1982–1991)
5a	Crary-Thiel trough	65°W and 30°W, 75°S and 85°S	NE-SW	1100	100 150 (in Thiel part)	Cenozoic	k31 (rift nature questionable; Russians map it as rift)	Masolov et al. (1981), Elverhøi and Maisey (1983), Anderson (1991)
5b	Western Antarctic taphrogen: Byrd subglacial basin and Bentley subglacial trough	120°W and 75°W, 75°S and 82°S	ENE-WSW	1100	400 (in W) 100 (in narrowest part) ~400 (in E)	middle Creta-ceous–Neogene inclusive	k31, g4	Jankowski and Drewry (1981), Jankowski et al. (1983)
5c	Western Antarctic taphrogen: Ross Sea subtaphrogen	160°E and 165°W, 70°S and 85°S	N-S (in N) NE-SW (in S)	2000	>1000 (in N) ~800 (in SW)	middle Creta-ceous–Neogene inclusive	k31, g4	Katz (1982), Barrett et al. (1991, 1995), Behrendt et al. (1991), Cooper et al. (1991a, 1991b), Rooney et al. (1991), Tessensohn and Wörner (1991), Brancolini et al. (1995), Childs et al. (1995), Davey and Brancolini (1995)
6	Aurora subglacial basin rift	117°E, 73°S	NNW-SSE	350	~60		k1	Masolov et al. (1981)
7	Denman Glacier	100°E, 66°30′S and 69°30′S	NNW-SSE	270	75	Cretaceous?	k1	Kadmina et al. (1983)
8	Shirase Glacier–Lützow-Holm	35°E and 50°E, 69°S and 77°S	NW-SE (in N) N-S (in S)	1000	150	Early? Creta-ceouswith Karroo ancestry	k1, g2 and g3	Kadmina et al. (1983)

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[199] The longitude and latitude limits represent only those of the Roraima Group (1600–700 Ma) as depicted in Walrond (1980). The "Younger Basic Group" is also confined within these limits (see Walrond, 1980, Fig. 1). No attempt has been made to consider other Roraima representatives that extend almost as far as the Andes (e.g., Gansser, 1974). We presume the rocks here delineated to be the limits of a Roraima rift that evolved coevally with the Younger Basic Group and the associated block faulting (1536 Ma and earlier).

[200] For taphrogeny in Antarctica in general, see Voronov (1964), Masolov et al. (1981), Bentley (1983, 1991), Ivanov (1983), Kadmina et al. (1983), Quilty (1987), Grikurov (1992).

TABLE 1. RIFTS OF THE WORLD *(continued)*

No.	Name	Location (bounding longitude and latitude)	Orientation	Length (km)	Width (km)	Age	Type of rift (Şengör, 1995) (see Fig. 2)	References
Antarctica *(continued)*								
9	Polar subglacial basin	One branch along 135°E from 85°S, across the pole to ~88°S Another branch along 85°S to 80°S NW-SE to meet Lambert rift	N-S and NW-SE	1800	>100	Early? Cretaceous	k1, g2 and g3	Stump and Fairbridge (1975)
10	Belgica Fjella	30°E, 68°S and 74°S	N-S	650	>250 (in N) 100 (in S)	Middle Jurassic–earliest Cretaceous	k1	Ivanov (1983), Kadmina et al. (1983)
11	Weddell	20°W and 35°W, 72°S and 75°S	NE-SW	600	50 (max) 0 (min)	Middle Jurassic	k22, g2?	Kristoffersen and Hinz (1991)
12	Pencksökket-Jutulstraumen	0°E, 70°S and 75°S	N-S to NW-SE	500	175 (in N) <100 (in S)	Early Jurassic	k1, g2?	Kadmina et al. (1983), Grantham and Hunter, (1991), Harris et al. (1991), Krynauw et al. (1991)
13	Wilkes Land taphrogen	125°E and 153°E, 67°30′S and 80°S	N-S NE-SW (in E)	1500	Taphrogen: 1000 (in N); 150 (in S) Individual rifts: 100 (avg)	Early to Middle Jurassic	k1, g3 (or g4)?	Ivanov (1983), Kadmina et al. (1983), Steed (1983), Steed and Drewry (1982)
14	Lambert rift (or International Geophysical Year rift)[201]	60°E and 75°E (offshoot rifts extend to at least 90°E), 65°S and 85°S	N-S NE-SW (offshoots to W) NW-SE (offshoots to E)	2000	200 (in N) ~100 (each branch in S)	Late Permian, then Early to middle Cretaceous	k1, g2 and g3	Drewry (1976), Masolov et al. (1981), Fedorov et al. (1982), Kurinin and Grikurov (1982), Ivanov (1983), Kadmina et al. (1983), Hofmann (1991), Andronikov and Egorov (1993), Arne et al. (1993), Mikhalsky et al. (1993), Webb and Fielding (1993)
15	Stefansson Bay	60°E, 65°S and 68°S	N-S	~350	~75	Permian?	k411 or k32, g3	Fedorov et al. (1982)
16	Magnet Bay	57°30′E, 65°S and 67°S	N-S	200	~60	Permian?	k411 or k32, g3	Fedorov et al. (1982)

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[201] This feature was discovered during the International Geophysical Year by the Russians who named it the IGY Valley, because it had been gradually unveiled by the joint efforts of Americans, Britons, Australians, and Russians. The depression localizes a tremendous flow of ice toward the Prydz Bay, the deepest indentation on the coast of Eastern Antarctica. This gigantic ice river was explored first by Australians who named it the Lambert Glacier. With time the handier name Lambert has come to replace the IGY and now the rift is widely known as the Lambert rift. By right of priority, however, it should be the IGY rift (see Sullivan, 1961, p. 334, and the relief map inside both covers).

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