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Sri Lanka: is it a Mid - Plate Platelet?

By

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ABSTRACT

Two observations suggest the possibility that Sri Lanka is acting as a small-mid-plate platelet moving very slowly within and relative to the larger Indian plate. First, sediments of the Bengal Deep-Sea Fan off the SSE continental margin are folded and uplifted in a manner similar to the deformation from front of accretionary prisms where thick sediment columns are passing into subduction zones. And second, subsidence rates in the area of presumed spreading or continuing stretching of continental crust, the Cauvery-Palk Strait-Gulf of Mannar Basin, have not decreased during the Cenozoic as would be predicted by an aborted rift or aulacogen model, but instead appear to have accelerated during the Neogene. Information available on other phenomena which are predicted by the model is at the present time inadequate for evaluation.

INTRODUCTION

Sri Lanka (Fig. 1) is an island measuring about 225x435 km, lying just southeast of the southern tip of the Indian Peninsula. Geologically, it bears a very close resemblance to the Precambrian high-grade crystalline metamorphic rocks of adjacent India. Although this makes Sri Lanka's position in reconstruction of Gondwanaland obviously close to India, its precise position has never been defined. Smith and Hallam (1970) adjusted Sri Lanka's position relative to India rather arbitrarily and in relatively small scale to constitute a best possible geometric fit. Subsequently Crawford (1974) repositioned Sri Lanka to bring it closer to India prior to breakup of Gondwanaland. Most recently Katz (1978) carefully analyzed evidence for approximately 200 km of late Mesozoic drift of Sri Lanka away from India with possible anti-clockwise rotation during early breakup of eastern Gondwanaland. The objective of this paper is to further analyze that migration in the light of new geophysical and drilling evidence from the Cauvery Basin and Palk Strait area between India and Sri Lanka, and in the light of apparent compressional deformation of deep - water sediments lying at the foot of the continental slope on the S.S.E. side of Sri Lanka.

Physiographically, Sri Lanka is rather anomalous. Its continental slopes descending to the floor of the Bay of Bengal are among the steepest in the world. Its continental shelves are narrow, except in the Palk Strait area. On land, the Physiography (Vitanage, 1970 and 1972) consists of three morphological regions: (a) the coastal lowlands, with elevation between sea level and 270 m, interrupted with a few isolated inselbergs; (b) the upland region, with elevations from 270 to 1060 m, with a ridge and valley topography and highly-dissected plateaus, occupying nearly 30% of the island; (c) the highlands, with a series of well-defined high plains and plateaus rimmed by mountain peaks and ridges with elevations from 910-2524 m. Concordance of levels is reported on each of these three surfaces, which have been interpreted as peneplains (Adams,

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1929; and Cooray, 1967). Vitanage (1970 and 1972) discounts earlier interpretations of major block faulting separating these three levels and interprets the morphology of the island as due to differential and perhaps continuing epeirogenic uplift, combined with differential erosion.

Reports of and evidence for neotectonic movement around the coastlines of Sri Lanka are generally non-quantitative and somewhat speculative. The unusually shallow shelf break, apparently ranging from about 35-70m, suggests continuing uplift. Raised Pleistocene beaches are reported along the west coast of Sri Lanka, and extensive beds of late Pleistocene corals and shells are found several km inland along the southwest coast. Deraniyagala (1958) reports evidence of human habitations once submerged, now located about 12m above sea level in the sand dunes along the southeast coast of Sri Lanka. Vitanage (1972) furthermore reports results of releveling surveys in different parts of the island which suggest changes in the elevation of as much as 1 mm/yr, in some places upward, in other places downward. More recently, Vitanage (in press) has plotted an axis of maximum uplift trending NE-SW across the SE third of the island (Figs. 1 and 6).

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In this paper, an attempt will be made to demonstrate that the Cauvery-Palk Strait-Gulf of Mannar Basin represents a failed rift or aulacogen, dating from the late Jurassic or early Cretaceous breakup of eastern Gondwanaland. Subsidence has, however, continued to the present time, with apparently higher rates of subsidence during the Neogene than previously. This would suggest slow, continuing separation of Sri Lanka in a south-southeasterly direction relative to India. Deformation of sediments of the Bengal Deep-Sea Fan at the foot of the continental slope off south-southeast Sri Lanka suggests compression, possibly continuing to the present time. A model is proposed that Sri Lanka during this time has acted as a mid-plate platelet moving slowly in a south-southeast direction relative to the Indian plate within which it lies.

Cauvery - Palk Strait - Gulf of Mannar Basin

Many investigators have concluded that a rift formed through the Cauvery-Palk Strait-Gulf of Mannar Basin region (Fig. 1) during breakup of eastern Gondwanaland in late Jurassic or early Cretaceous time (see, for example, Katz, 1978; Crawford, 1974; Curray and Moore, 1974; Thompson, 1976; Cantwell *et al.*, 1978; Curray *et al.*, 1982; Withjack and Gallagher, in press). The present structure (Figs. 2 and 3) shows a northeast-southwest trending horst and graben system. This trend is perpendicular to the presumed direction of first motion of India from formerly contiguous Antarctica during early Cretaceous (Curray and Moore, 1974; Johnson *et al.*, 1976; Norton and Sclater, 1978; and Curray *et al.*, 1982; Similar structural trends are found in the other sedimentary basins of the east coast of India, the Palar, the Godavari-Krishna, the Mahanadi, and the West Bengal Basins. This trend is parallel to the alignment of the continental margin north of the bight of India and is parallel to the "hinge-line" runining beneath the Bengal Basin(Evans, 1964). This hinge-line has been interpreted as approximately the edge of continental crust (Curray and Moore, 1974; Curray *et al.*, 1982). Along the north-south trending continental margin of the east coast of southern India, these structural alignments project out to sea into the Bay of Bengal, and are presumably terminated at some point beneath the continental slope or at the edge of continental crust.

The stratigraphy of the Cauvery Basin and Palk Strait area, as determined from both th surface geology and drilling results (see, for example Sastri *et al.* 1973 and 1981; Cantwe *et al.*, 1978; and Withjack and Gallagher, in press), extends from upper Jurassic to Holocene. Th upper Jurassic and part of the lower Cretaceous are considered upper Gondawana sediments an are continental. Best exposures occur on the Indian side, on the western flank of the Cauver Basin, but three small outcrop areas of upper Jurassic occur in northwestern Sri Lanka. Mos of the remainder of the section, from early Cretaceous to Holocene, is marine, ranging fro shore-zone to marine facies of outer continental shelf depths. In some of the other basins on th east of India, for example in the Godavari-Krishna Basin, lower Gondwana sediments of pre Jurassic age are found mainly in the northwest-southeast-trending Pranhiti-Godavari Graben.

In a simplistic classification, the lower Gondwana sediments can be considered pre-rift, i that they were deposited prior to the rifting phase which led to the breakup of eastern Gondwanaland. The upper Gondwana sediments, and perhaps some of the marine Cretaceous, Paleocene, and even Eocene can be considered syn-rift. Whereas breakup and the start of drifting or sea floor. spreading are thought to have occurred in early Cretaceous along this continental margin, the horst and graben normal faulting apparently continued from late Jurassic at least through the Eocene. It is, therefore, difficult to draw a line between the synrift and post-rift phases and sediments without access to better seismic reflection data than are available to me. Relief between the horsts and grabens was great enough that even the Miocene section is significantly thinned over the horsts. Minor normal faulting involving the crystalline basement and folding occured through the Neogene.

Major unconformities occur between lower and upper Cretaceous and at the base of the Eocene, and other less widely-distributed unconformities occur in both the Paleogene and Neogene sections. At least some of these, such as the middle Cretaceous unconformity, might be attributed to sea level changes (Vail, 1977). A clear breakup unconformity (Falvey, 1974) cannot be identified with an age compatible with the spreading histories proposed for this region (see references previously cited). The pre-upper Gondwana, late Jurassic unconformity over crystalline basement would appear to be too early, perhaps more nearly coinciding with the onset of rifting, and the middle Cretaceous unconformity is probably too late and is coincident with the middle Cretaceous eustatic event (Vail, 1977). A pre-early Cretaceous unconformity does occur, however, in the Mahanadi, Godavari, Krishna, and Palar Basins (Sastri *et al.*, 1980) which would be more nearly compatible with the spreading and breakup histories proposed. I conclnded, however, that the present constraints on the timing of the breakup and initiation of sea floor spreading for this margin are at the present too poor for us to be concerned about correation with a possible breakup unconformity.

The Cauvery-Palk Strait-Gulf of Mannar Basin consists of two sectors: a passive continental margin sector facing the Bay of Bengal, and an aulacogen sector, or failed rift. Offshore seismic and drilling results for the continental margin sector are not available to me, but the Cenozoic postrift sedimentary section presumably completely blankets the horst and graben structure and continues on down the continental slope, perhaps reaching its maximum thickness beneath the outer shelf or shelf edge. In this study, we are concerned primarily with the aulacogen sector, or the failed rift between Sri Lanka and India, which underwent extension during the early breakup of Gondwanaland but failed to continue to the sea floor spreading stage with generation of oceanic crust.

A sedimentary basin undergoing extension experiences three kinds of subsidence (McKenzie, 1978; Royden *et al.*, 1980; Le Pichon and Sibuet, 1981; Le Pichon *et al.*, 1982). First is what Mekenzie has termed the initial subsidence conceived to occur essentially instantaneously on a geological time scale, due to stretching of the lithosphere while maintaining isostatic adjustment. Second is thermal subsidence, due to thickening of the lithosphere by heat conduction to the surface. And third is subsidence due to isostatic loading by sediments.

A fourth kind of subsidence an alternative to stretching of the lithosphere during the initial stage is densification of the lithosphere by injection by ultrabasic dikes (Royden *et al.* 1980). The result is subsidence which is generally indistinguishable from the stretching model, again conceived to occur instantaneously on a geological time scale.

These mechanisms of subsidence apply either to a continental margin which passes into the sea floor spreading stage, such as the open continental margin of the northern Cauvery Basin or to a failed or aborted rift which does not pass into the sea floor spreading stage, such as the southern Cauvery-Palk Strait part of the Basin. The initial subsidence is, in the case of the southern Cauvery-Palk Strait part of the Basin, at least in large part due to stretching, as manifested by horst and graben extensional faulting. Onset of the stretching is the onset of rifting, in late Jurassic. Thermal subsidence and subsidence due to sediment loading then follow with a time constant assumed to be 63 my. Thus this phase of subsidence reaches 63% of its maximum value in 63 my, and 87% in 125 my.

This is the current status of the theory of basin subsidence. Let us next compare the subsidence history of the aulacogen sector of the southern Cauvery-Palk Strait portion of the Basin with this theory.

Subsidence in a sedimentary basin is most easily determined by sediment thicknesses, assuming that all sediments are deposited essentially at sea level, and thus the basin is always full during its subsidence history. As we shall discuss later, this is not always a valid assumption.

Sediment accumulation curves, which on the assumption stated above approximate subsidence curves, are plotted for nine wells in the Cauvery-Palk Strait Mannar Basin which penetrated to basement. Data for the wells came from Sastri *et al.* (1973), Cantwell *et al.* (1978), and from un published well data provided by the Ceylon Petroleum Corporation. The curves approximate cumulative subsidence of the basement surface at the well since the start of accumulation of sediments. In some cases this is shown as the assumed time of break up of this part of east Gondwanaland, or about 130 my, early Cretaceous. Obviously sediment accumulation did not start at the same time at each well site. Some bias is introduced because the wells were sited on the tops or flanks of horsts, and deposition was initiated at later times, well after the presumed break up time. The positions of the curves vary considerably, both by position relative to the structure, and relative to the location within the basin. In general, curves for wells located farther to the northwest have different shapes than those located farther to the southeast or east. All, however, show a hump or bulge above a linear trend for the Paleogene. Taken at face value, this hump would imply a continuing increase in rates of subsidence since the initiation of subsidence, and especially during the Neogene. Such an increase markedly deviates from the subsidence theory described above, which predicts "instantaneous" initial subsidence, followed by decreasing rates as a function of the square root of time.

One possible source of deviation of the curves from the predictions is that the assumption that all sediments were deposited at sea level is not a valid. Some estimates of environment of deposition of the sediments are possible from the same sources of information as the sediment thicknesses. Facies change across the basin, from more continental on the NW and close to Sri Lanka to more marine or deeper water in the center of the basin or offshore into the Bay of Bengal. Our interest here is primarily in the center or toward the Sri Lanka side of the Palk Strait part of the basin and in the general area of the wells utilized in the northern Cauvery Basin in Figures 2 and 3. The approximate environments are as follows, greatly simplified, and with an attempt to convert vague terminology, such as "inner sublittoral", etc. to equivalent parts of a continental shelf and to absolute water depths:

Lower Cretaceous - continental, supratidal, to inner shelf, including reef facies; from about +20 m to —20 m.

Upper Cretaceous - shore-zone to inner shelf; about 0 to -20 m.
Paleocene - inner shelf; about 0 to —20 m.
Eocene - inner to outer continental shelf; about -20 to -200 m.
Oligocene - inner to outer shelf and possible upper continental slope; -20 to possibly -500m.
It would be important to know whether the deeper water facies are upper or lower Oligocene, but this is indeterminate from the data available to me.

Miocene - shoals upward in the section from outer shelf to inner shelf; about -200 to-20 m.
Pliocene - subtidal to inner shelf; about 0 to -20 m.

Thus, in summary, the possibility appears that during parts of the Eocene to lower Miocene, the basin was not full, and the sea floor may have been as deep as 200 m. at times, and possibly at some time during the Oligocene as deep as 500 m. Correcting for this would move the curves deeper in the graph by these amounts during this time, thereby in part reducing the size of the humps in the curves.

Another factor which must be considered, however, is sea level changes, such as the curve of global sea level changes for this period of time proposed by Vail *et al.* (1977). Insufficient information is available for detailed examination of possible correlation with this curve, but some general correlations are evident.

The middle Cretaceous unconformity appears coincident with a major fall in sea level, so this unconformity may or may not be tectonic in origin. The basal Eocene unconformity does not precisely correlate with a proposed sea level fall, although Vail does show major drops in sea level between lower and upper Paleocene and between lower and middle and middle and upper Eocene, which may correlate with some of the unconformities reported. The most significant sea level fall Vail shows is in lower upper Oligocene. This is a sea level fall which would presumably be of the order of a few hundred meters, from a relatively high sea level, above that of the present, to a level below that of the present. This could possibly explain the report of "upper bathyal", or equivalent to upper continental slope depths, but the data available are not sufficient for confirmation of this possibility.

In the light of the proposed extreme fluctuation of global sea level, especially during the Tertiary, I conclude that detailed corrections of the subsidence curves are unwarranted. Vail does, however, indicate a generally high sea level for late Createaceous through middle Oligocene time, with lower but rising sea levels during lower and middle Miocene. Those Paleogene high sea levels could explain the relatively deep water in the Palk Strait part of the basin.

The real significance of these subsidence curves is that they do not show any tendency of a decrease in the rates through time, and in fact appear to show a Neogene acceleration in subsidence. If the southern part of the Cauvery-Palk Strait-Mannar Basin is a simple aulacogen, or failed rift, which started rifting in early Cretaceous, the rates should have decreased markedly during the Neogene. At two time constants, or about 130 my, 87% of the ultimate subsidence should have been attained, and the subsidence curves would have flattened considerably. Approximate theoretical subsidence curves are plotted in Figure 4 for the limiting wells, PTK, in the Cauvery Basin, and *Mannar* located in the Palk Strait area. These curves are calculated from Royden *et al.* (1980) on the assumption that stretching to give the known subsidence of basement at those sites had all occured approximately 130 Ma., and that no additional stretching, or densification of the lithosphere, had occured thereafter, and with limiting assumed sedimentary rock densities of 2.5 and 2.0, respectively. Rapid early subsidence would have been followed by a continuing decrease in the subsidence rates.

One possible conclusion from this analysis is that stretching or densification, of the lithosphere continued throughout the Cretaceous and Cenozoic.

The Continental Margins of Sri Lanka

The continental margins of Sri Lanka (Fig. 1) are not well surveyed geologically and geophysically. Some proprietary oil exploration surveys have been run; descriptions, without copies of the records, of some reconnaissance seismic lines run by the USSR Technoexpert Group exist in the files of the Ceylon Petroleum Corporation; and my collegues and I have crossed the margins a few times, principally on our way into and out of the port of Colombo.

This is one of the steepest continental slopes in the world. Locally, our bathymetric compilation (Fig. 1) demonstrates slopes of a minimum of 45° on the eastern side of the island, between depths of 500 and 4000 m. The shelves are generally narrow, averaging about 20 km in width.

The sediment section appears to be thick off the north point of Sri Lanka in the offshore portion of the Cauvery-Palk Strait-Gulf of Mannar Basin. Where known, the Tertiary part of the section continues in general to thicken offshore. Proceeding around toward the southeast, the section thins on the shelf to 500 to 700 m at about 8°15' N, and the continental slope is apparently bare of sediments. This same distribution continues the rest of the way south on the eastern margin, and westward on the southern margin, locally attaining a thickness of perhaps 900 m on the shelf. No rock dredge samples are known from this apparently-bare continental slope.

The sediment section on both the shelf and slope increase northward on the western margin, grading into the Gulf of Mannar. No structural or seismic information is available to me in the Gulf of Mannar, but this is presumably the south and southwestward continuation of the Cauvery-Palk Strait Basin. I would expect a sediment section at least as thick as in the northern and central part of the basin, and a continuation of the northeast-southwest rift structures.

An anomalous feature appears at the foot of the continental slope off the SSE side of the island (Figs 5 and 6). Sediments of the Bengal Deep-Sea Fan appear to be compressed and folded to above the level of the adjacent fan surface. Nature of the faulting associated with the folding is often indeterminate in the records, and could be either normal or reversed, although in association with the folding, it is highly likely that it is reversed or even thrusting. Between the deformation front and the steep slopes of the pinnacles and other irregular topography of the lower continental slope is a terrace or plateau, underlain by the uplifted fan sediments. At the eastern edge of the plateau the strata dip offshore (Fig. 5A); in the central part of the plateau the strata dip landward toward the continental slope (Figs. 5B and C.)

The possible alternative explanation for this structure as down-slumping from higher on the slope or shelf edge has been rejected for two reasons. Firtst, careful study of the seismic reflection records clearly demonstrates that the stratigraphy of this uplifted section is the same as that of the adjacent fan; and second, this deformed section is thicker than the sediment section on either the shelf or slope above.

In working on these records, my colleagues and I have always interpreted this zone as the deformation front of the accretionary prism of a subduction zone (David G. Moore, personal communicatiion, 1968). The structure is strikingly similar to the deformation front of the Sunda subduction zone in the eastern Bengal Fan off and the Andaman and Nicobar Islands (Curray and Moore, 1971; 1974); Curray *et al.*, 1982) and to the deformed sediments in other parts of the world where a thick sediment section rides the lower plate into a subduction zone (see, for example, Silver, 1971 and 1972; White and Klitgord 1976; and White and Ross 1979). In each of these expamples, the sediment sections is thick and the component of subduction normal to the strike of the subduction. zone is small.

My tentative conclusion from the subsidence evedence in the Cauvery-Palk Strait-Gulf of Mannar Basin and from the deformation and uplift of Bengal fan sediments is that Sri Lanka is a mid-plate platelet moving in a SSE direction within and relative to the larger Indian Plate.

Tests of the Mid-Plate Platelet Model

Other phenomena commonly associated with spreading axes, transform faults, and subduction zones should be investigated to test this model. Unfortunately, information available to me is insufficient at the present time to evaluate these other phenomena, by but-they will each be reviewed in this section.

Plate edges are generally delineated by seismicity. Shallow-focus earthquakes occur along spreading axes and transform faults, and a Benioff zone of shallow to at least intermediate-focus earthquakes usually occurs at a subduction zone. A plot of large teleseismic earthquakes around Sri Lanka shows little activity and no pattern (Char-Shine Liu, personal communication- 1982) Earthquakes are, however, known in Sri Lanka (Tissa Munasinghe personal communication, 1983), but no plots of small earthquakes or microseismicity are possible with available data at this time (Asoka Senanayake, personal communication, 1983). The criterian of seismicity cannot, therefore, be evaluated at this time. Neotectonism is well known (Vitanage 1970, 1972, and personal communication, 1983), so it is evident that something is occurring. Vitanage has, furthermore, shown an axis of maximum uplift which paralles the presumed subduction zone and preading axis (Fig. 6).

A thermal anomaly would be expected within or beneath the thick sediment section along the presumed spreading axis, or offset system of spreading axes (Fig. 2). Thermal anomalies are not known, but thus far exploration for oil and gas has not been extensive nor detailed, and the anomalies may be small and localized. If present, such anomalies could be very important for maturation of organic material to hydrocarbons, and, if other criteria tend to favour the model, exploration for these anomalies would be worthwhile.

A lithospheric phenomenon reported by Rajaram *et al.* (1979) may be related to the extension which has and may still be occuring in this Strait area. It is the "presence of a conducting channel in the lower crust or upper mantle", which causes transient geomagnetic variations. Depth control is, however, very weak in this analysis, and this phenomenon may or may not be of significance to this discussion (Alan Chave, personal communication, 1982).

Volcanism, usually about andesitic in composition, almost always occurs above subduction zones. The exceptions may, however, be important: places where continental crust is passing into a subduotion zone, and places where the component of subduction is very low because of extremely oblique subduction, as in the western Aleutians and northern Sunda Arc.

No volcanism occurs in Sri Lanka, although there are hot springs along the shear zone marking the boundary between the Highland Series rocks from the eastern Vijayan rocks. This trend is a bit east of north and runs into the sea down the Trincomalee submarine canyon (Fig. 1). These hot springs may or may not be of significance to the model proposed.

One of the largest long-period gravity anomalies on earth, as detected by satellite measurements, lies in a crescent south of Sri Lanka. Shipboard gravity measurements also show a large negative anomaly, the largest observed in the Bay of Bengal (Fig 7, and Liu *et al.*, 1982). Four closed contours of - 100 milligal anomalies flank Sri Lanka, with one lying in the area of the proposed subduction zone. It is not known how much of this may be an edge effect of the apparent sharp transition from continental to oceanic crust, but the largest anomalies do not lie adjacent to the steepest continental slope on the east side of the island. Once again, the significance of these anomalies is not known.

Sediment column thicknesses could be related to the gravity anomalies, but if so, the relationship is not abvious (Fig. 8). One of the major thick lobes of sediment of the Bengal Fan lies off the eastern continental margin of India and extends southward on the east side of Sri Lanka. This lobe is separated from the other major lobe of the Bengal Fan by the 85° E Ridge (Liu *et al.*, 1982); Curry *et al.*, 1982). This preliminery isopach map may not properly portray the sediment thicknesses near the Sri Lanka continental margin, where the arching of the deeper sediment layers at the foot of the slope (Fig. 5) is tentatively interpreted as indicating a thinning sediment column. Better seismic information, both reflection and refraction, is needed to delineate the true sediment thicknesses and configuration of the basement surface in this region, as well as to delineate the continental from the oceanic crust.

Finally, if Sri Lanka does constitute a platelet moving to the SSE, strike slip, or transform, faulting should occur off the east and west margins. Seismic records do show faulting, but the trends and nature of offset of these faults cannot be determined with available data.

In conclusion, insufficient information exists to evaluate the other phenomenan commonly associated with the plate edges which are predicted by this mode.

Geological History

A geological history scenario for the northeastern Indian Ocean has been published by Curray and Moore (1974) and Curray *et al.*, (1982), which will form the basis for a very brief review here (Fig 9). Further details may be found in those publications, or in the other references given earlier in this paper.

I favor the reconstruction of eastern Gondwanaland shown in Figure 9A and in more detail in Figure 10. This is generally the fit of Smith and Hallam, as modified mainly by Crawford (1974) and Griffiths (1974). Breakup is assumed to have occured at about 130 my, and India and Sri Lanka together moved away from Antarctica and Australia in a direction approximately perpendicular to the NE-SW- trending coastline of the northwestern Bay of Bengal. A major plate reorganization occurred at about 90 my, and another in the time span 53 to 32 my, now demonstrated to have been within a shorter time span of about 53 to 45 my (Liu *et al.*, in press)˙ It is the early spreading history which mainly concerns us here, and then the apparent independent subsequent motion of Sri Lanka relative to India.

Estimates of rates of the motion from 130 to 90 my range from 2.9 to 3.5 cm/yr. in contrast with the subsequent rates of 10.8 to 12.8 cm/yr after the 90-my reorganization (Curray *et al*, in preparation). It would appear that the first rifting between India, Sri Lanka, and Antarctica occurred through the Cauvery-Palk Strait-Gulf of Mannar zone, but this rift did not progress into the sea floor spreading stage. Instead, the break occured between Sri Lanka and Anatarctica. This break may not have been preceded by any of the usual events of stretching of continental crust and the underlying parts of the lithosphere. For example, no rifting or other Jurassic or Cretaceous extensional structures are known along the east and south margins of Sri Lanka. For this reason, I do not believe that the outer continental margins of Sri Lanka have had a subsidence history common for passive continental margins, either rift-origin segments or transform fault-origin segments. This is an important characteristic of Sri Lanka's continental margins.

Katz (1978) has carefully analyzed the post-Gondwana separation of Sri Lanka from India, and has estimated a total separation of the order of 200 km. The basis for this estimate is the separation of "boundary faults" in India and Sri Lanka, 200 km apart, which he restores as the proto-boundary fault. I suspect that this figure is too high, and the boundary faults are actually the outer bounds of the zone of rifting. The original width of this zone is unknown, but I would doubt that the stretching factor B (MeKenzie, 1978) would be greater than 2. This would mean an original width of about 100 km and a total separation of the same amount. Thus an *average* rate of separation assuming 100 km in 130 my, would be about 0.8 mm/yr. If subsidence accelerated in the Neogene, the rate might have been approximately 1 mm/yr.

Tectonic Implications of the Model

This is, I believe, the first time that a model of a mid-plate platelet has been proposed The evidence is clearly not compelling, but is suggestive. Other supporting evidence must be collected and evaluated before the model can be considered very seriously, but it is for this reason that I propose the model at the present time and with such tenuous evidence. I especially hope that compilations and further work on the distribution and focal mechanisms of small earthquakes and microseismicity can be collected. The slight possibility of thermal anomalies in the Cauvery-Palk Strait-Gulf of Mannar basin should be kept in mind by those involved in the exploration for hydrocarbons. Also, further evidence on subsidence should be collected and evaluated. The neotectonics of Sri Lanka must be further studied and evaluated. Finally, and perhaps equally important as the need for studies of seismicity, better seismic information must be collected at sea, both reflection and refraction. The structures in the area of presumed continuing stretching and rifting should be better delineated, and deep seismic refraction studies should be conducted to determine crustal nature and thickness, to determine if oceanic crust is being formed by deep intrusion into the lower sediment column, or if continental crust is still being stretched. Faulting must be evaluated along the trends of the presumed transform margins, and better definition of the structure in the presumed subduction zone in essential.

If this model is valid, it would have important implications on the mechanism of plate motion. This would be platelet approximately 125 km thick, 250 km wide, and 500 km long. What would be the driving mechanism for such a size an and shape of body? How is this related to the extreme neotectonics reported for the island of Sri Lanka by Vitanage?

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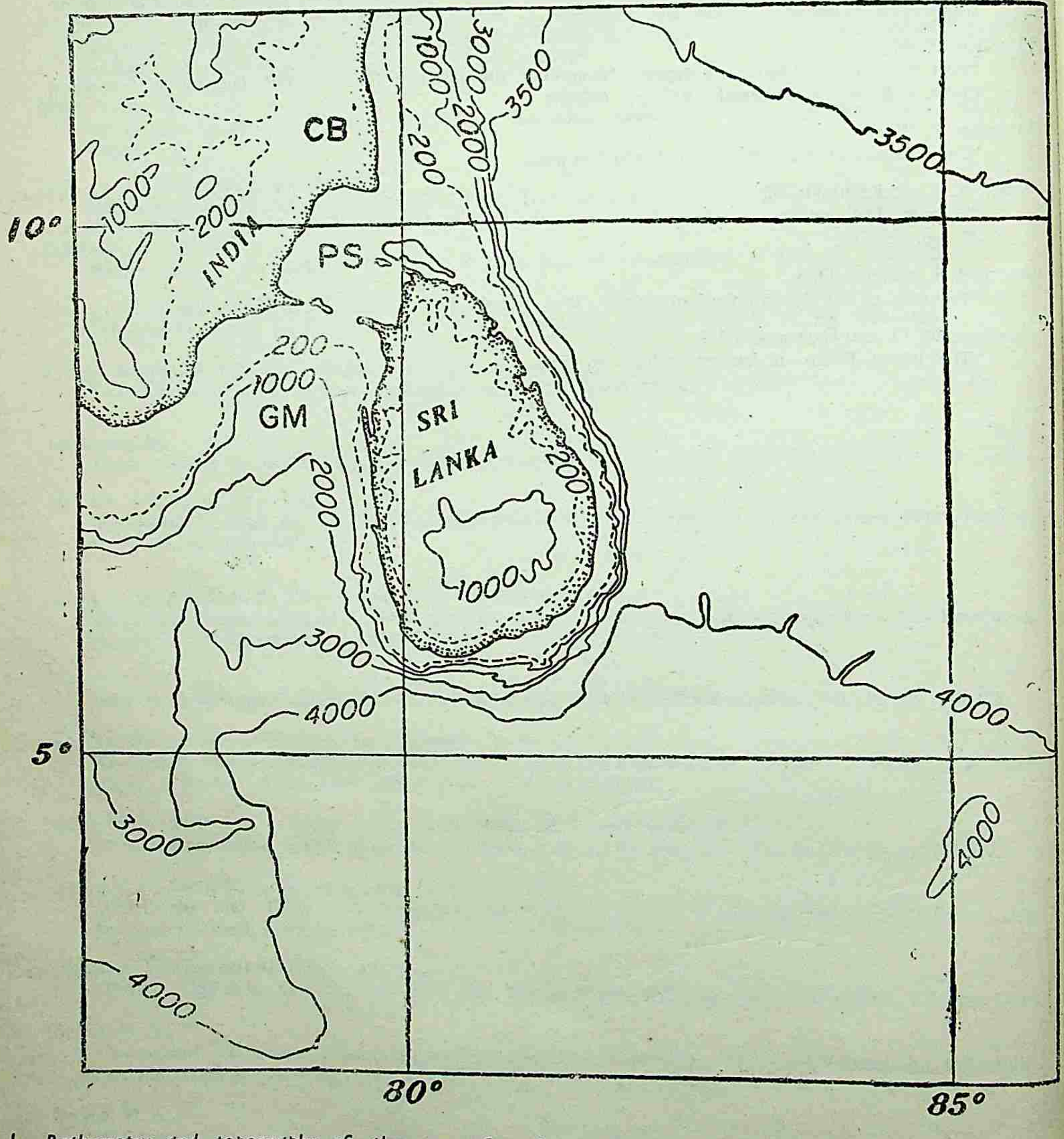
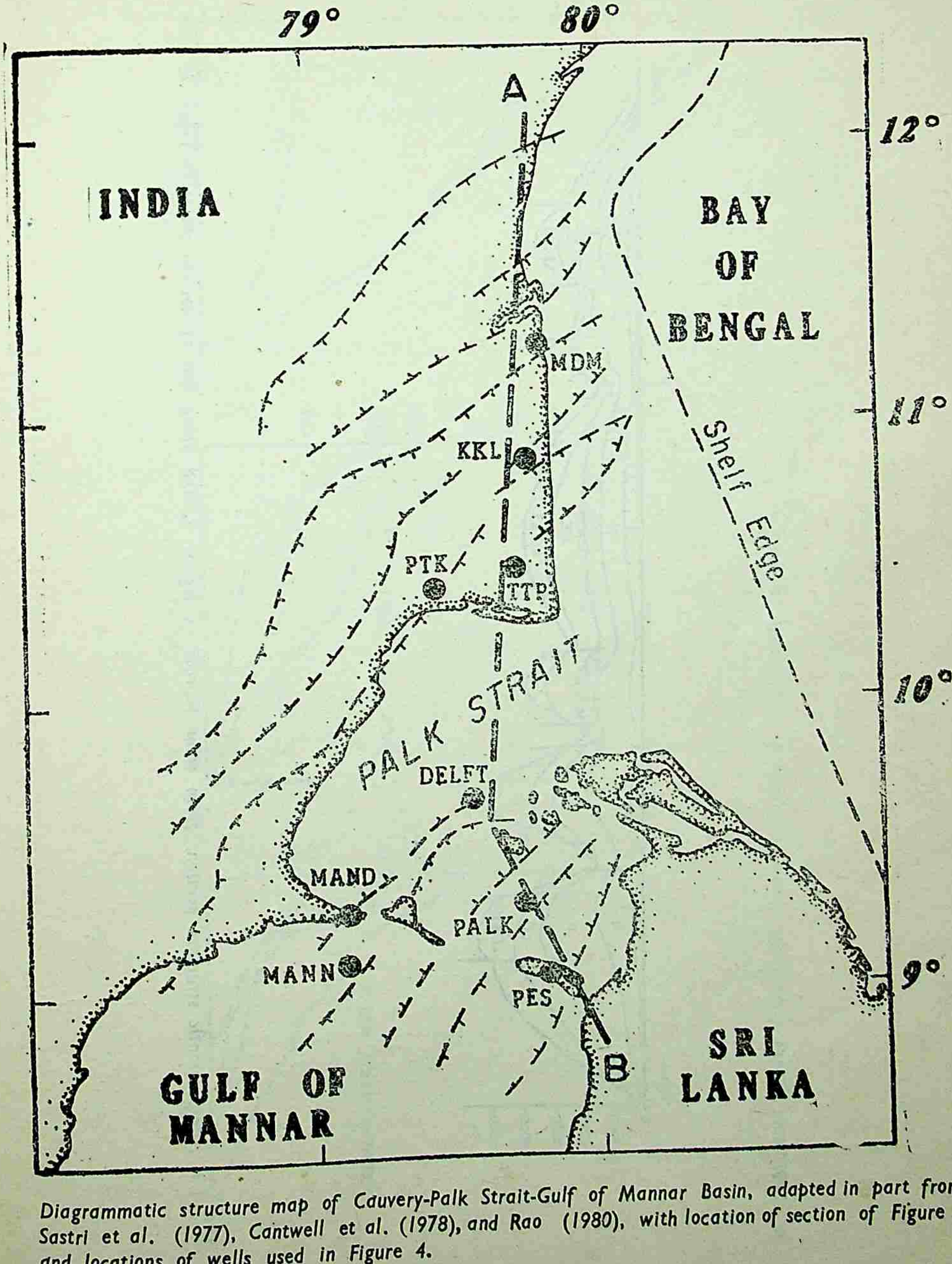
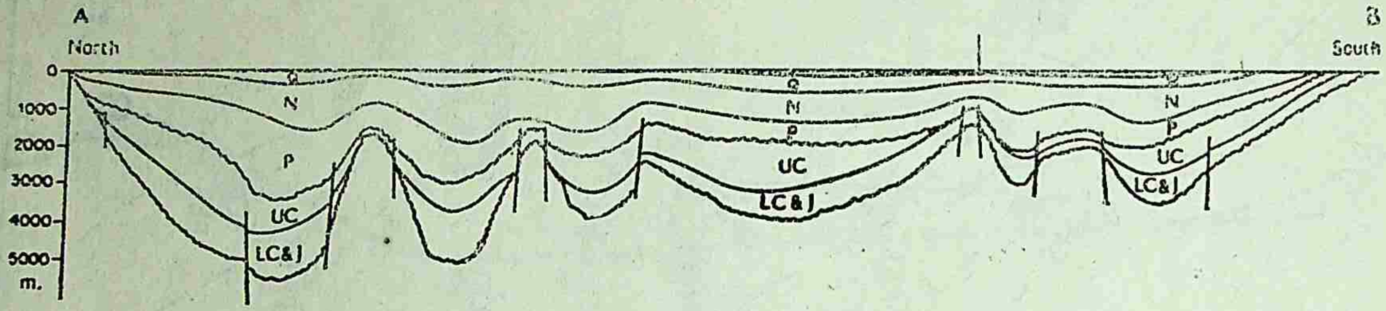


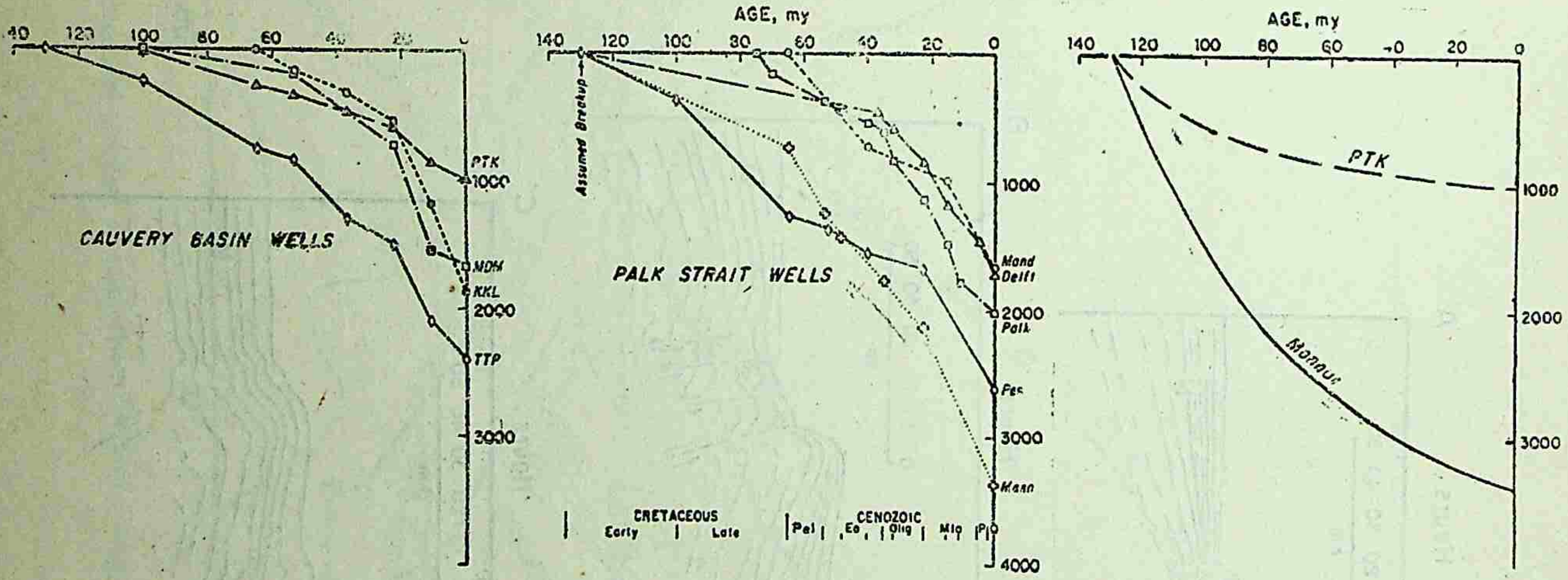
1. Bathymetry and topography of the area of study, with contours in meters. Submarine depths ar calculated at assumed sound velocity of 1500 m/s. C. B. is Cauvery Basin; P. S. is Palk Strait; G.M is Gulf of Mannar.



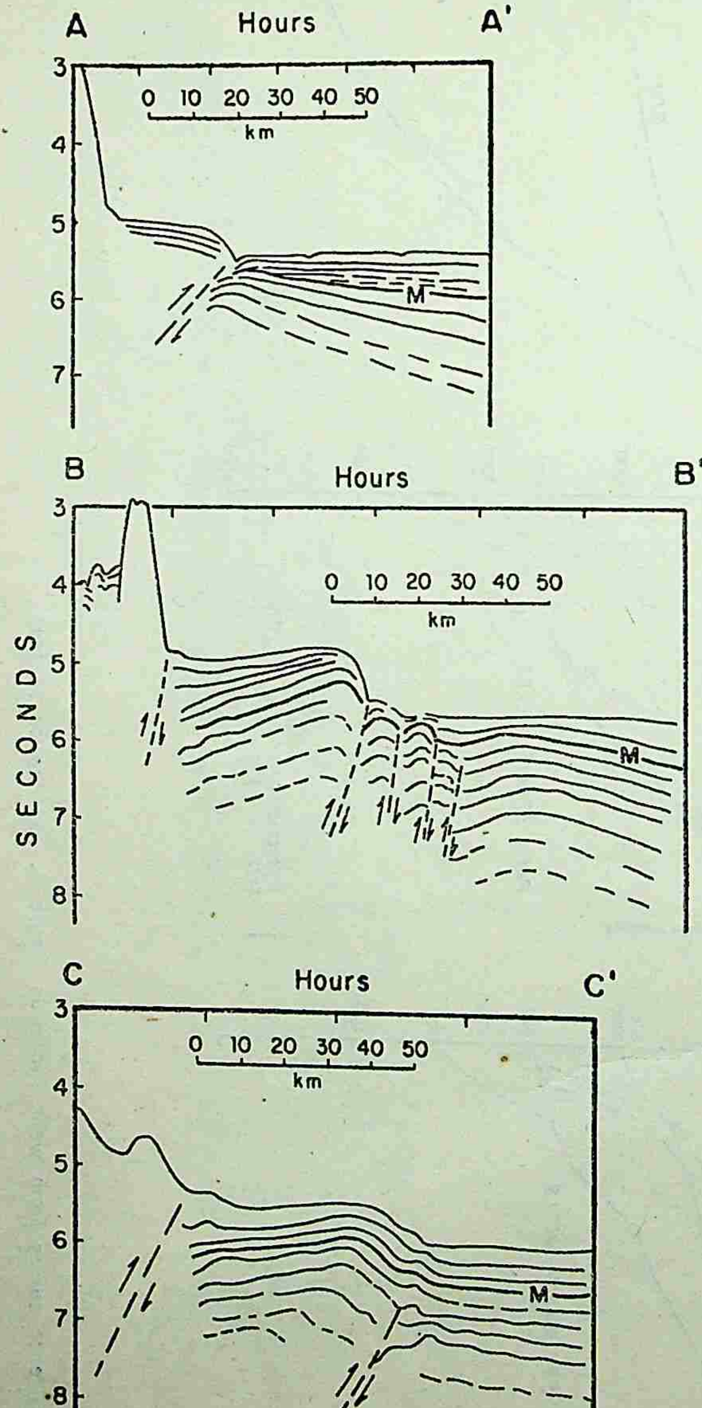
Diagrammatic structure map of Cauvery-Palk Strait-Gulf of Mannar Basin, adapted in part from Sastri et al. (1977), Cantwell et al. (1978), and Rao (1980), with location of section of Figure 3 and locations of wells used in Figure 4.



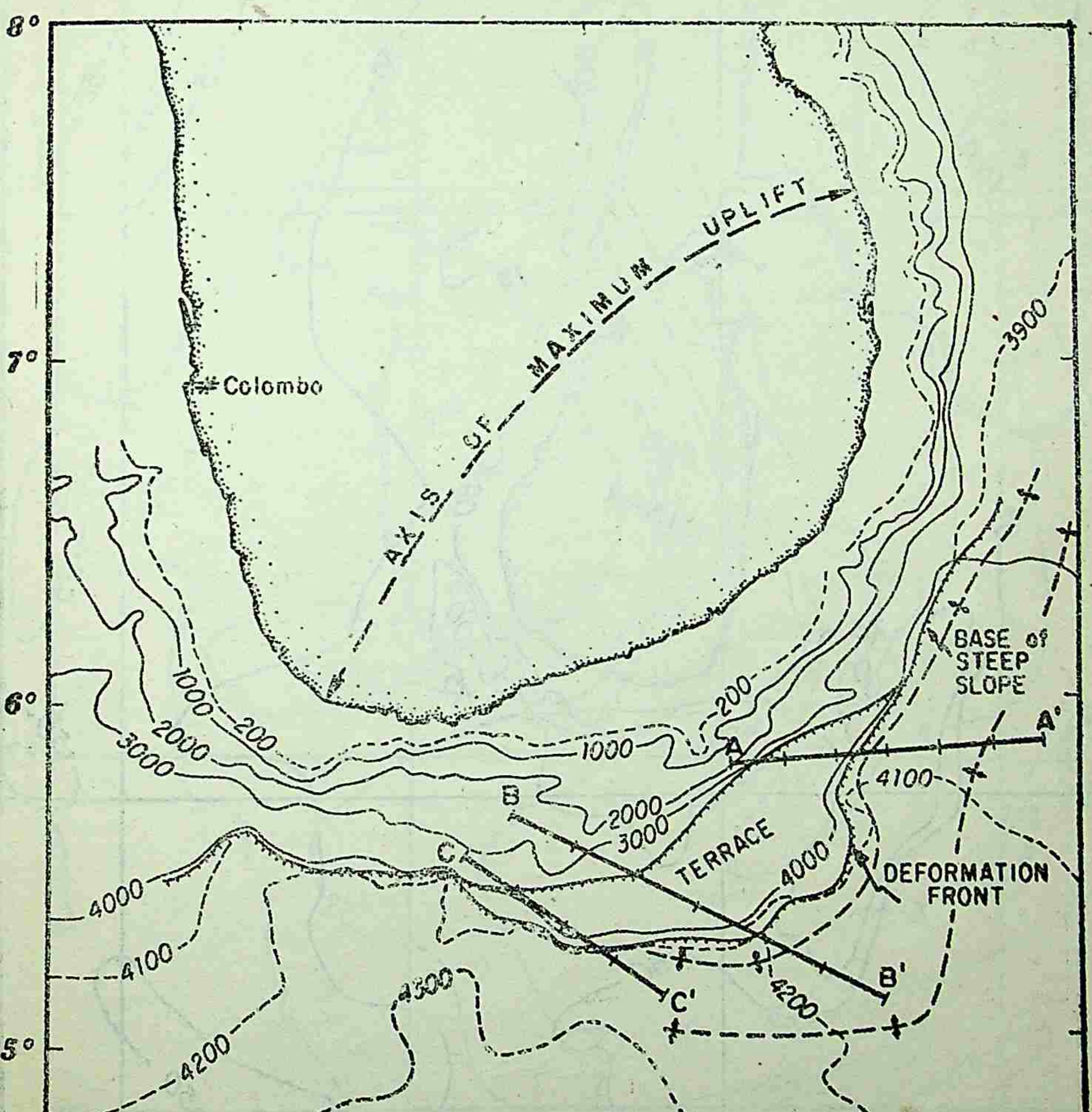
3. *Diagrammatic structure section, from sdme sources as Figure 2, and along line of section shown in Figure 2.*



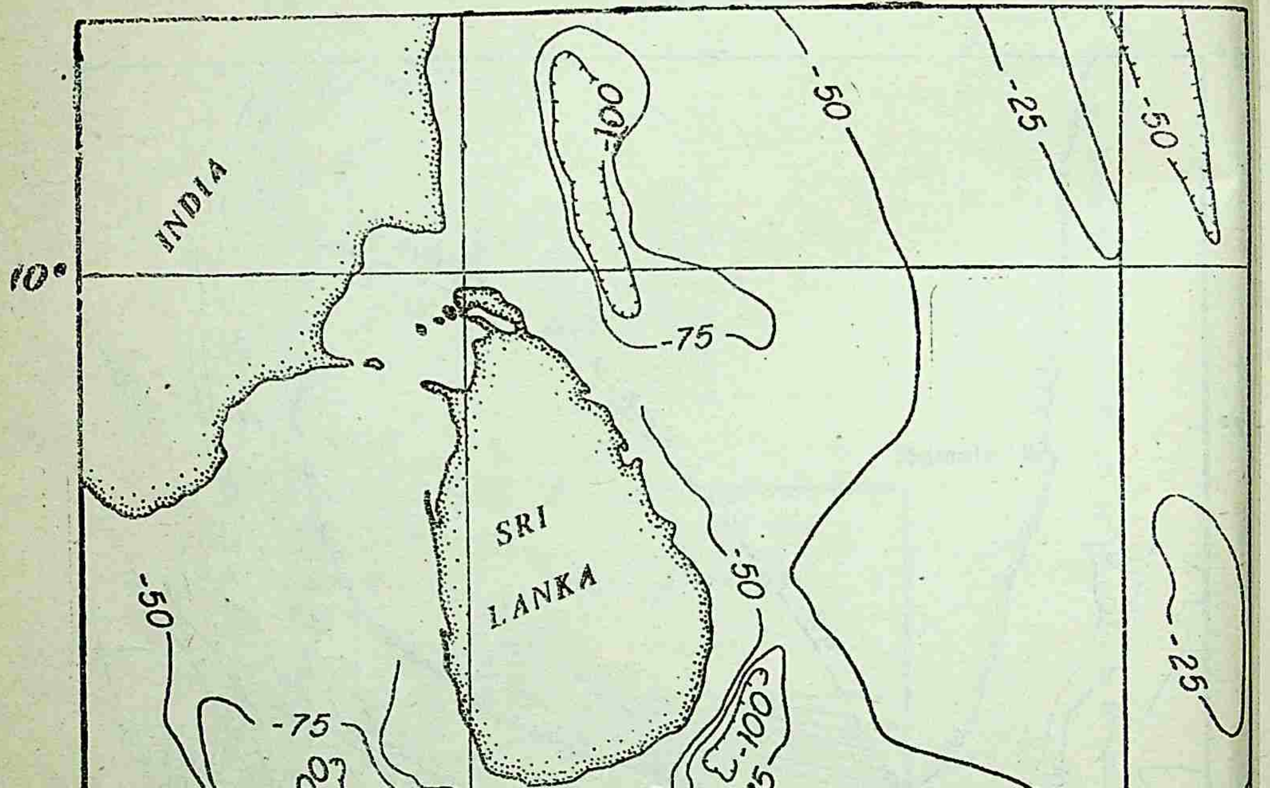
4. Subsidence curves from wells shown in Figure 2. Explanation in text.



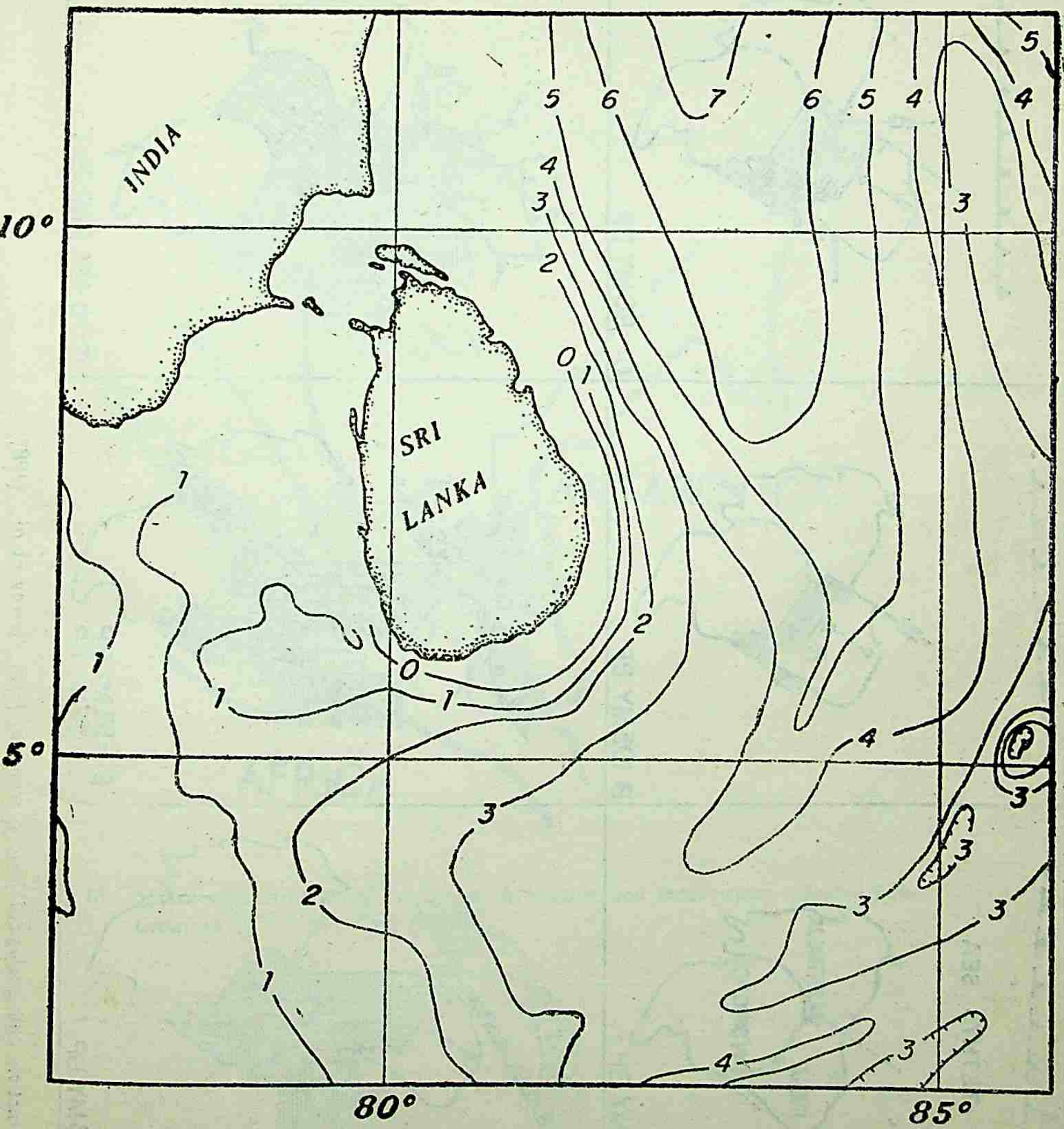
5. Line drawings of seismic reflection records. Locations shown in Figure 6. M is upper Miocene unconformity.



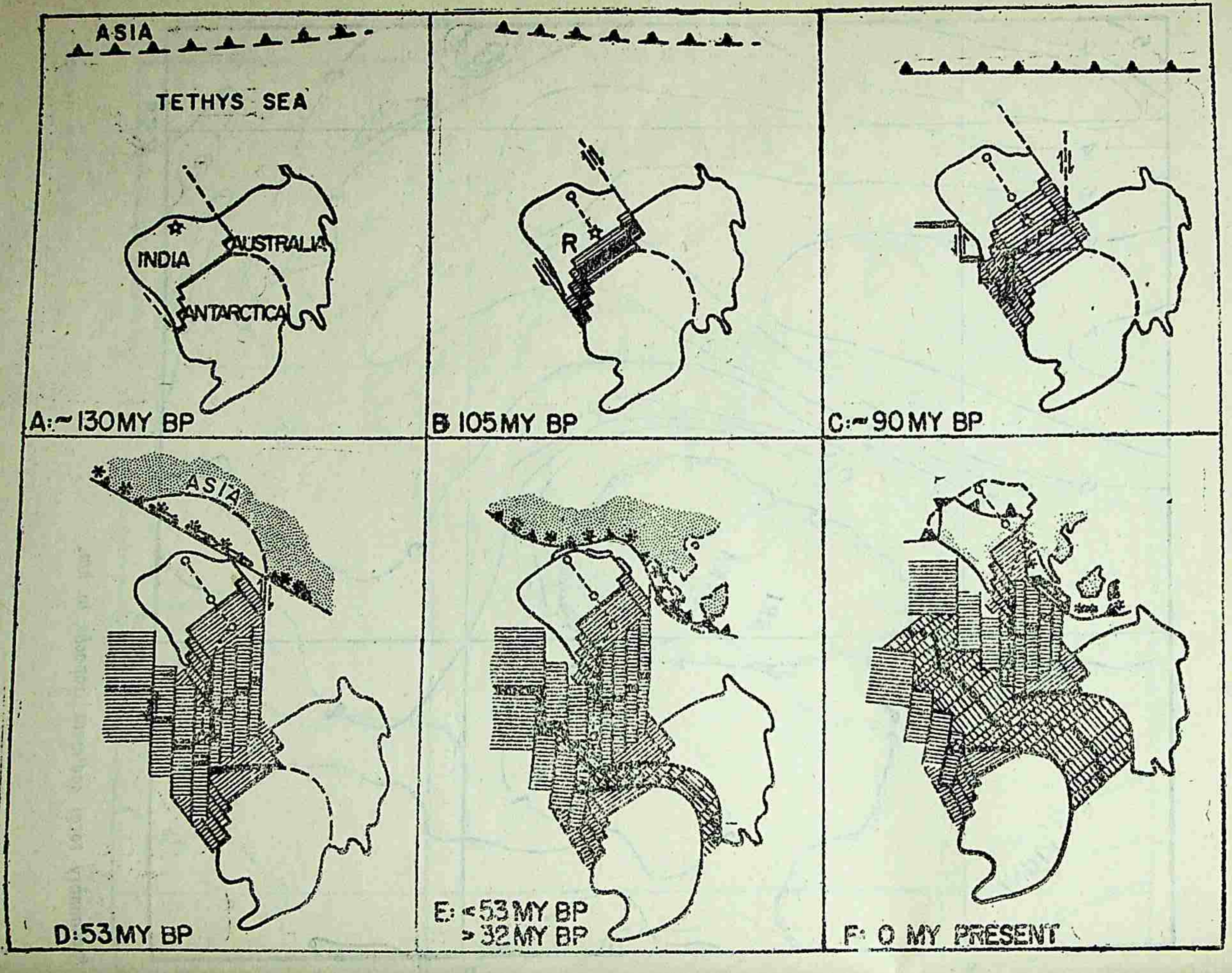
'6. Bathymetry and structural elements of southeastern Sri Lanka, with location of sections of Figure 5.



7. Free air gravity, from Liu et al. (1982).



8. *Preliminary total sediment isopachs in km.*



9. Reconstruction and geological history scenario, from Curray *et al.* (1982).