Supporting Information

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SI Text

Geology. Approximately 150 kg of amber pieces 1–15 cm in length were collected from outcrops exposed within large lignite mines in Gujarat state, western India, specifically Vastan (N 21° 25.239, E 073° 07.249) and Tadkeshwar (N 21° 21.400, E 073° 04.532), and Rajpardi (N 21° 42.444, E 073° 13.793). A small amount of amber was collected in Matusukh (approximately N 21.2°, E 73.6°), in Rajasthan state. These mines cut through extensive sequences of the Cambay Shale Formation, a 75–1500-m-thick layer of dense, glauconitic clay with seams of lignite, which was deposited in an intracratonic graben that trends NNW–SSE, called the Cambay Basin (Fig. 1*A*). The Basin lies between the Deccan traps on each side of the Gulf of Cambay and extends through Gujarat and Rajasthan. The lowermost basin fill units are the Paleocene-Lower Eocene-aged Vagadkhol Formation (and its equivalent, the Olpad Formation), which directly overlies the Deccan Traps. These are overlain by the Late Paleocene-Middle Eocene-aged Cambay Formation, which can be subdivided into the Older Cambay Shale and the Younger Cambay Shale. In the Vastan mine is a 20–145-m-thick unit of interbedded lignite beds, shales, carbonates, and clay marls, which is lithologically equivalent to the Older Cambay Shale.

The amber is concentrated in two strata of thick lignite seams, called "lignite [layer] 1" near the middle of the exposed sequence in the Vastan mine, and "lignite 2" at the bottom of the exposed sequence. These two layers are separated by over 20 m of calcareous clays, claystones, lignitic shale, and some thinner layers of lignite, representing possibly 1–2 myr difference in age. The great bulk of amber comes from lignite 1, because there is far greater exposed area of this layer. A mid- to early-Ypresian age (*ca.* 50–52 Ma) of the Older Cambay Shale is indicated by shark teeth (S1), by the index foraminiferan *Nummulites burdigalensis burdigalensis* found between the upper and lower lignite seams at Vastan (S2), dinoflagellates (S3), pollen, and lithology (S4).

In the Cambay Shale system, sediment input was probably seasonal, controlled by the equatorial climate, with the bulk of the sediment derived from chemical weathering of the thick and highly erodible Deccan Traps (5). The predominance of mud-rich sediments, together with lignites and siderite in the Vastan, Tadkeshwar, and Rajpardi mines, suggests deposition in a predominantly low-energy, near-shore/coastal setting similar to the existing chenier and chenier plain system along the northeast coast of South America, where the mud-dominated environments occupy a belt about 1600 km along the coast and up to 50-km wide (5). Dense mangrove systems fringed the coast of the Eocene muddy shelf that formed the Cambay shale, contributing significant amounts of organic matter.

In the Vastan and Tadkeshwar mines layers 5–10-cm thick of "amber conglomerate" were deposited (Fig. S1*B*), consisting entirely of resin fragments ranging from the size of sand grains to several millimeters, but with scattered pieces 5–10 cm in length (SI Fig. S2*B*). The layers appear to be stranded shoreline wrack concentrated by low-energy transgressions and regressions. Amber was buried in situ or with very little reworking, based on the presence of extremely fragile flows of amber, some attached to fossil wood and with delicate drops and runnels covering the piece (Figs. S1*D* and S2*A*).

Diverse plant macrofossils also occur at the Vastan and Tadkeshwar mines. Unidentified compressions of angiosperm leaves and flowers are found in the lignitic shale just above lignite 1, along with rare fruits (which also occur just above lignite 2 layer at the Vastan mine, near a layer with diverse vertebrates). The fruits have been identified as similar to certain modern genera in the Rhamnaceae, Combretaceae, and Lythraceae (6), further illustrating that these deposits comprised tropical rainforest.

Amber. Cambay amber physically varies somewhat among mines, though with great overlap. Amber from Rajpardi is dark red to blackish, containing dense bubbles and surface pitting; it was probably baked by paleofire or hot ash (this condition precluded screening it for inclusions). Amber from the Vastan mine is similar but with more transparency. Amber from Matusukh and Tadkeshwar is more homogeneous, the former of which is darkened by a suspension of fine particles; the latter mine yields the largest transparent pieces (e.g., Fig. 1*E*). Pyrolysis/gas chromatography of samples from the Vastan, Tadkeshwar, and Matusukh mines indicates an identical botanical source, and there was no observable variation in amber composition between amber samples from lignite layers 1 and 2 within the Vastan mine. Class II or dammar-type resin (cadinene-based polymers) (S7) are produced in large quantities by trees in the Dipterocarpaceae (S8), and why the Cambay amber was attributed to that family (S9, S10). Class II resins are also produced by Cornaceae (S8), which is why definitive botanical attribution of chemically analyzed amber should also derive from identified plant macrofossils (see *Associated Wood*, below). Cornaceae can be excluded as a source of Cambay amber.

The poorly crosslinked molecular composition of Cambay amber allows complete dissolution in certain organic solvents such as toluene and chloroform, which in turn allows full extraction of inclusions. Extraction of insect inclusions through the use of solvents (chloroform) has also been reported with Early Cretaceous Lebanese amber (S11), but that amber (and the inclusions) disintegrates and fragments rather than fully dissolves.

Associated Wood. Nonpermineralized wood is abundant with amber in the Cambay Shale lignites, but it is poorly preserved. Much of it has layers of fossilized resin covering one surface, and some pieces contain small lenses of resin within the wood (Fig. S1*D*). Several dozen samples were examined for microscopic anatomy (e.g., Fig. S1*C*), one of which (sample TADK-8) yielded sufficient diagnostic information, which is a section of a branch that exhibits better preservation (Fig. S3). Cornaceae (the other family producing Class II resins) as a source of the fossil wood can be ruled out anatomically based on the following feature, which is consistent alternatively with Dipterocarpaceae: Perforation plates in the vessels are simple, not scalariform as in Cornaceae.

Description of Fossil Wood Specimen TADK-8. The fossil wood is diffuse porous with no distinct growth rings. There was no apparent pattern in the distribution of vessels on the transverse surface. The vessels are generally solitary or occasionally in radial multiples of 2–4. The index of vessel grouping (where the total number of vessels is divided by the total number of vessel groups; equaled 1.24. The outline of solitary vessels is circular to oval. The vessel tangential diameter ranged from approximately 70–170 μm (average = 100 μm, SD = 22.3, $n = 36$). The vessel density varied from 25 to 38 per square millimeter (average = 32, $n = 6$). The perforation plates of vessels are simple (Fig. S3*B*). Round to hexagonal shaped intervessel pits are arranged in an alternate pattern (Fig. S3*C*) and range from 5 to 9 μm in diameter (Fig. S3*D*). The rays are multiseriate with a width of one to three

cells wide (Fig. S3*E*). Wood fibers are generally thin-walled and nonseptate fibers present (Fig. S3*F*). The vessel-ray pits appear to have much reduced borders to apparently simple borders and the pits are rounded (Fig. S3*G*). The ray body cells are procumbent and are generally bounded by one row of upright and/or square marginal cells (Fig. S3*H*). Axial resin canals are diffusely distributed (Fig. S3*A*).

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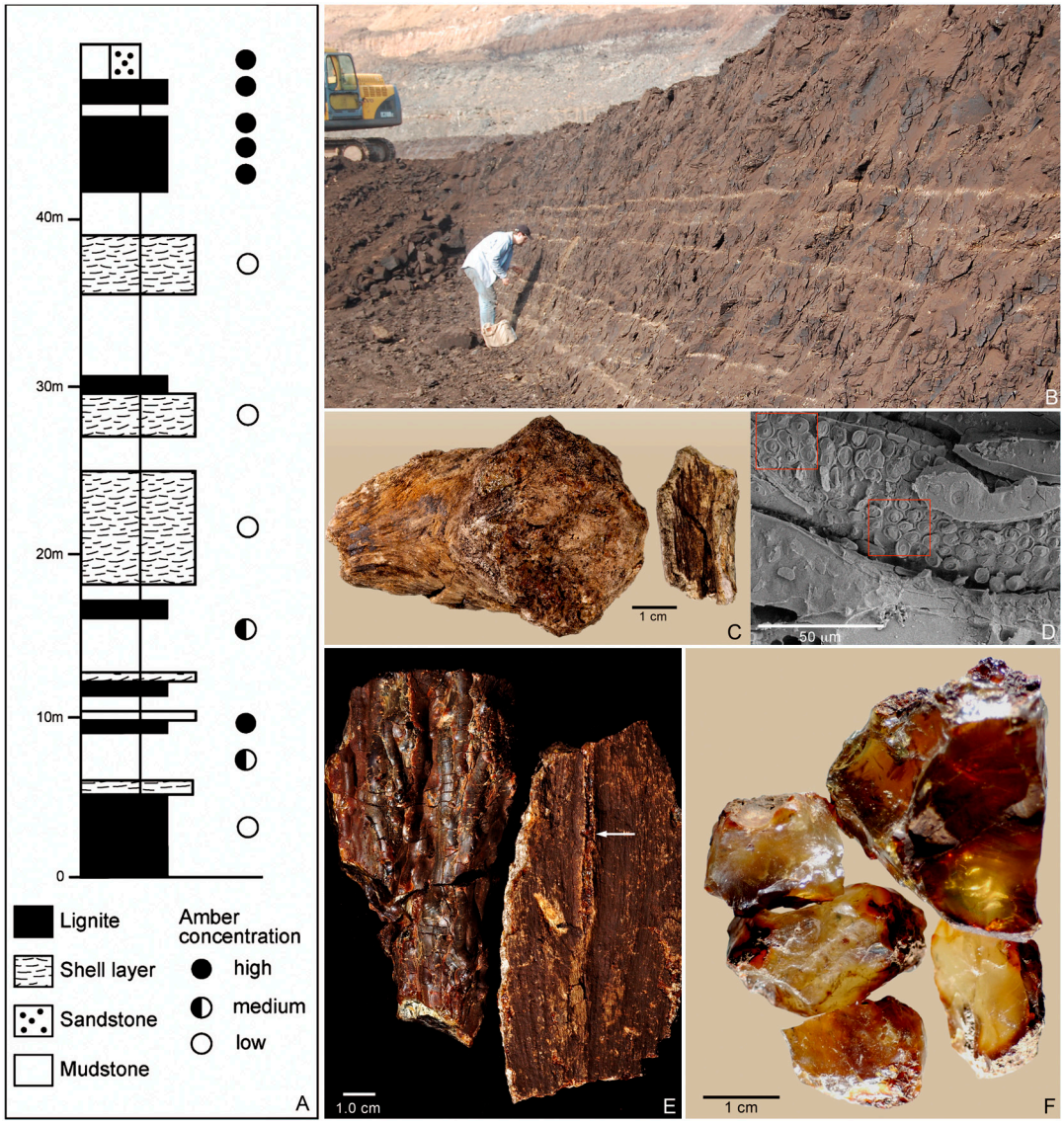

Fig. S1. (*A*) Stratigraphic sequence of the Older Cambay Shale from the Vastan and Tadkeshwar mines, showing concentrations of amber (from ref. S5) (*B*) Section through the upper amber layer at Tadkeshwar. The parallel light bands are layers of amber conglomerate. (*C*) Pieces of fossil dipterocarp wood with embedded amber, from the upper amber layer of Tadkeshwar. (*D*) SEM showing intervessel pitting, with circular, alternately arranged pits having slit-shaped openings. (*E*) Large piece of an amber flow (*Left*) that was attached to a piece of fossil wood (*Right*). Arrow indicates a seam of amber within the wood. (*F*) Representative pieces of transparent Cambay amber.

Fig. S2. (*A*) Large amber flow from the Tadkeshwar mine, showing drips and runnels. Preservation of delicate pieces like this example indicates deposition in a low-energy paleoenvironment and undisturbed preservation. (*B*) Large piece of amber, in situ.

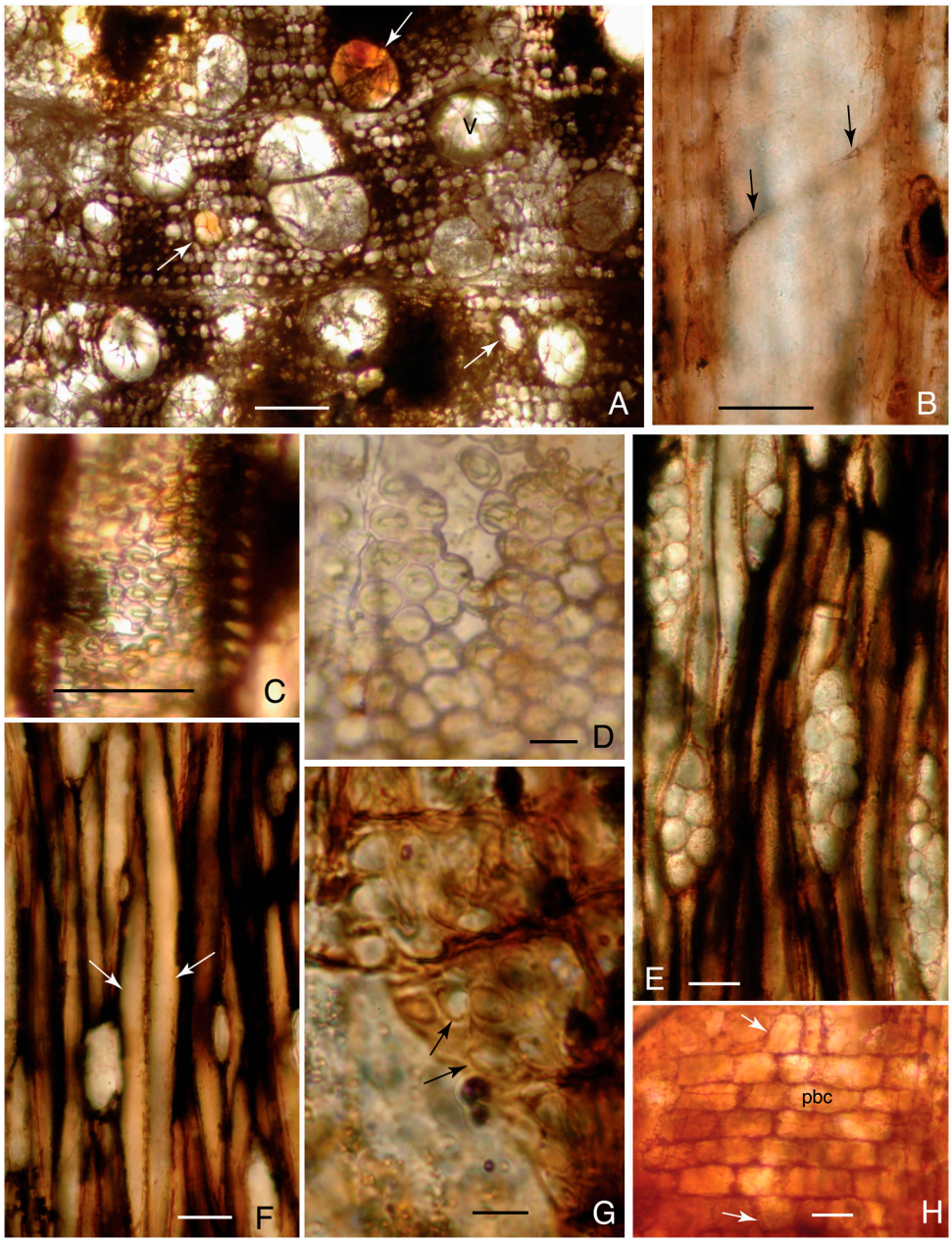

Fig. S3. Photomicrographs of wood anatomy of fossil wood sample TADK-8 from the Cambay Shale Formation (Paleocene-Eocene), Tadkeshwar lignite mine, Gujarat, India. (*A*) Transverse thin-section showing solitary and multiple vessels (V) and diffuse axial resin canals (white arrows). (Scale bar, 110 μm.) . (*B*) A simple perforation plate in tangential view, arrows indicate the perforation rim. (Scale bar, 140 μm.) (*C*) Tangential section showing circular to oval intervessel pits arranged in an alternate pattern. (Scale bar, 65 μm.) (*D*) Tangential view of alternate hexagonal intervessel pits. (Scale bar, 10 μm.) (*E*) Tangential view of biseriate rays. (Scale bar, 45 μm.) (*F*) Tangential view of short, nonseptate, thin-walled fibers. (Scale bar, 60 μm.) (*G*) Oblique radial view of vessel-ray pits (arrows). (Scale bar, 10 μm.) (*H*) Radial view of ray cells. Body ray cells are procumbent (pbc) with one row of upright and/or square marginal cells. (Scale bar, 50 μm.)