Triassic Rifting and Tethyan Paleoenvironment of a NE-Gondwanan Passive Margin (Thakkhola, Nepal)

TALK

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The Mesozoic sediments of the Thakkhola (central Nepal) were deposited on a broad eastern north Gondwanan passive margin at mid-latitudes (28-41°S) facing the Southern Tethys ocean to the north. The facies is strikingly similar over a distance of several thousand km from Ladakh in the west to Tibet and to the paleogeographically adjacent Northwest Australian margin (Exmouth Plateau, ODP Legs 122/123) and Timor in the east. Late Paleozoic rifting led to the opening of the Neo-Tethys Ocean in Early Triassic times. An almost uninterrupted, ca. 2 km-thick sequence of syn-rift sediments was deposited on a slowly subsiding shelf and slope from Scythian (Early Triassic) to late Valanginian times when breakup between Gondwana (NW Australia) and Greater India formed the proto-Indian Ocean.

The sedimentation is controlled by (1) global events (eustasy; climatic/oceanographic changes due to latitudinal drift; plate reorganization leading to rift-type blockfaulting) and (2) local factors, such as varying fluviodeltaic sediment input, especially during Permian and late Norian times. Sea level was extremely low in Permian, high in Scythian to Carnian and low again during Rhaeto-Liassic times. Third-order sea level cycles were distinguished in the Scythian and late Norian to Rhaeto-Liassic.

During the Permian pure quartz sand and gravel were deposited as shallowing-upward series of submarine channel or barrier island sands. The high compositional maturity is typical of a stable craton-type hinterland, uplifted during a major rifting episode.

During the Scythian a 20-30 m thick, composite, condensed sequence of nodular "ammonitico rosso"-type marlstone with a "pelagic" ammonite-pelecypod- calcisphere-ostracode-fauna was deposited (Tamba Kurkur Formation). This indicates rapid tectonic subsidence and sediment starvation during the transgression of the Neo-Tethys ocean.

After a hiatus (?), a 400 m thick sequence of fining-upward, filament-rich wackestone/shale cycles was deposited in a bathyal environment (Mukut Limestone Formation, Carnian). This is overlain by about 300 m of sandy shale and siltstone intercalated with quartz-rich bioclastic grain- to rudstone (Tarap Shale Formation, late Carnian-Norian).
The upper Norian to (?lower) "Rhaetian" Quartzite Formation (Thini Formation, 250 m) consists of (sub)arkosic sandstones, rich in K-feldspar and pure quartz arenites, indicating different sediment sources. The fluviodeltaic sandstones are intercalated with silty shale, coal, bioclastic limestone (including algal bindstone and mollusc floatstone), as well as mixed siliciclastic-bioclastic rocks. The depositional environment was marginal-marine to shallow-subtidal. The fluviodeltaic influence

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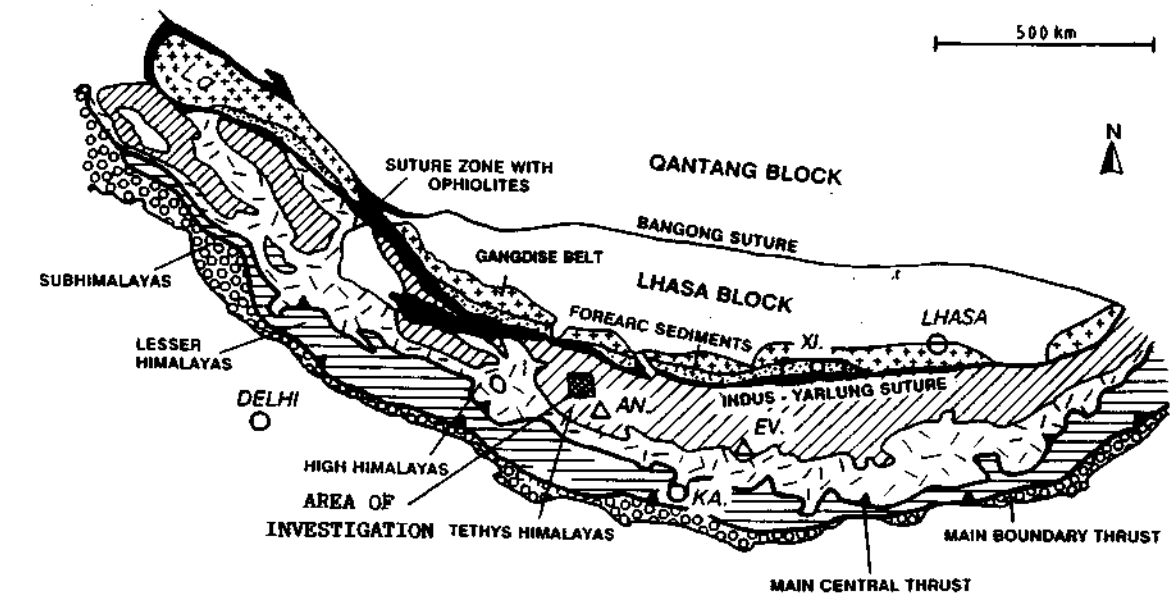
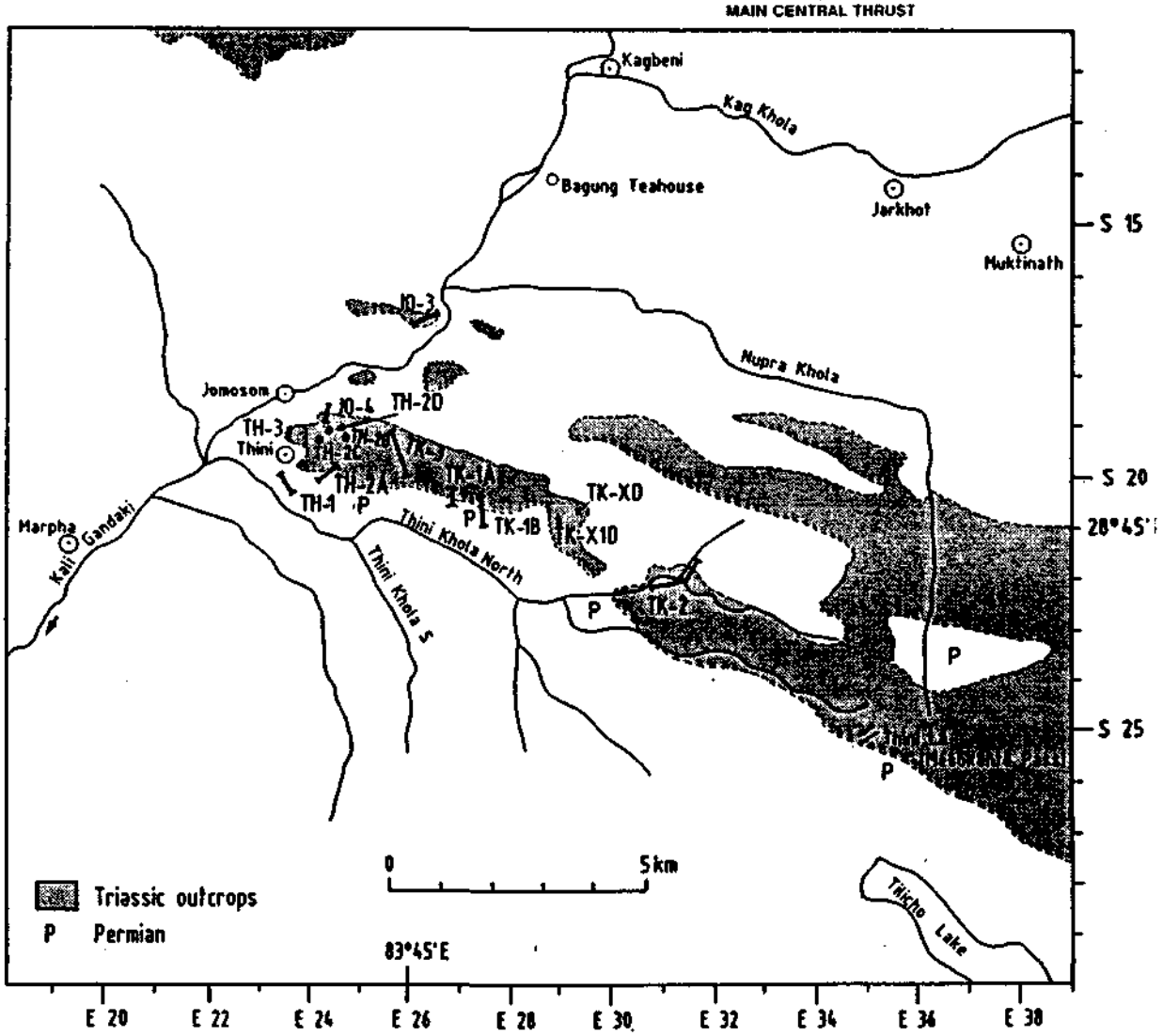
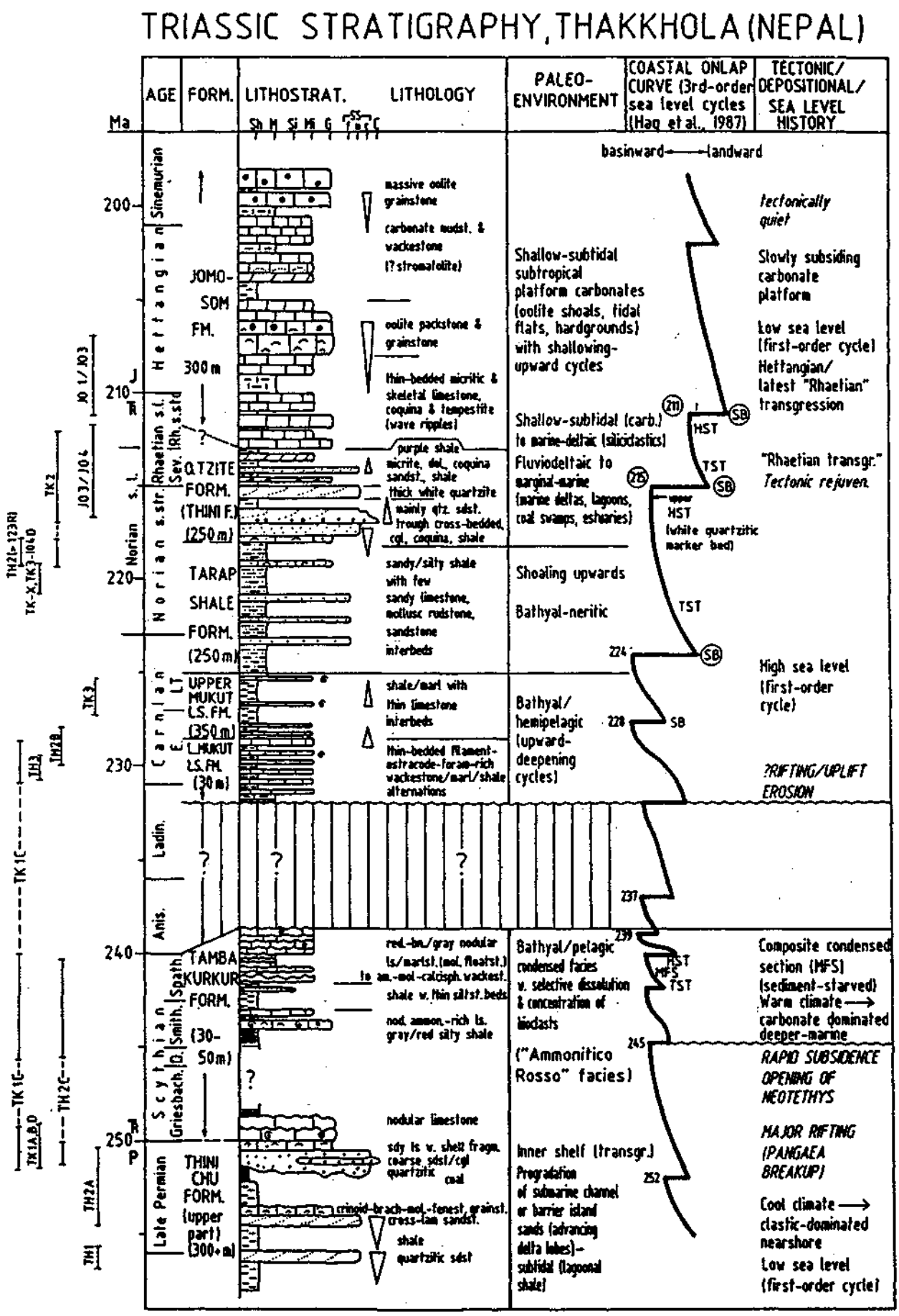
decreased towards the overlying Rhaeto-Liassic carbonates of the Jomosom Formation (correlative to the Kioto Limestone). During that time the region entered tropical paleolatitudes resulting in platform carbonates and local reefs (e.g. at Exmouth Plateau).






TRIASSIC STRATIGRAPHY, THAKKHOLA (NEPAL)
AGE
FORM.
LITHOSTRAT.
LITHOLOGY
PALEO-ENVIRONMENT
COASTAL ONLAP CURVE (3rd-order sea level cycles (Haq et al., 1987)
TECTONIC/ DEPOSITIONAL/ SEA LEVEL HISTORY
Ma
basinward
landward
massive oolite grainstone
carbonate mudst. & wackestone (? stromatolite)
oolite packstone & grainstone
thin-bedded micritic & skeletal limestone, coquina & tempestite (wave ripples)
purple shale
micrite, del., coquina sandst., shale
thick white quartzite
mainly qtz. sdst. trough cross-bedded, cgl., coquina, shale
sandy/silty shale with few sandy limestone, mollusc rudstone, sandstone interbeds
shale/marl with thin limestone interbeds
thin-bedded filament-ostracode-foram-rich wackestone/marl/shale alternations
red.-bn./gray nodular ls/marlst. (mol. floatst.) to am.-mol.-calcisph. wackest.
shale w. thin siltst. beds
nod. ammon.-rich ls. gray/red silty shale
nodular limestone
sdy ls v. shell fragm.
coarse sdst/cgl
quartzitic coal
crinoid-brach-mol.-forest. grainst.
cross-lam sandst.
shale
quartzitic sdst
JOMO-SOM FM. 300 m
Q.TZITE FORM. (THINI F.) (250 m)
TARAP SHALE FORM. (250 m)
UPPER MUKUT LS. FM. (350 m)
LMUKUT LS. FM. (30 m)
TAMBA KURKUR FORM. (30-50 m)
THINI CHU FORM. (upper part) (300+ m)
Hettangian
Sinemurian
Rhaetian s.l.
Rhaetian s.str.
Sev. (Rh. s.std)
Norian s.l.
Norian s.str.
Carnian
Ladin.
Anis.
Spath.
Griesbach.
Smith.
Scythian
Late Permian
Shallow-subtidal subtropical platform carbonates (oolite shoals, tidal flats, hardgrounds) with shallowing-upward cycles
Shallow-subtidal (carb.) to marine-deltaic (siliciclastics)
Fluviodeltaic to marginal-marine (marine deltas, lagoons, coal swamps, estuaries)
Shoaling upwards
Bathyal-neritic
Bathyal/ hemipelagic (upward-deepening cycles)
Bathyal/pelagic condensed facies v. selective dissolution & concentration of fossils
("Ammonitico Rosso" facies)
Inner shelf (transgr.) Progradation of submarine channel or barrier island sands (advancing delta lobes)– subtidal (lagoonal shale)
tectonically quiet
Slowly subsiding carbonate platform
Low sea level (first-order cycle)
Hettangian/ latest "Rhaetian" transgression
"Rhaetian transgr." Tectonic rejuven.
High sea level (first-order cycle)
?RIFTING/UPLIFT EROSION
Composite condensed section (MFS) (sediment-starved) Warm climate → carbonate dominated deeper-marine
RAPID SUBSIDENCE OPENING OF NEOTETHYS
MAJOR RIFTING (PANGAEA BREAKUP)
Cool climate → clastic-dominated nearshore
Low sea level (first-order cycle)
HST
TST
SB
MFS
upper HST (white quartzitic marker bed)
211
216
224
228
237
239
245
252
200
210
220
230
240
250
TK2
TK3
TK1C
TK1G
TK1A,B,D
TH2C
TH2A
TH1
TH2B
TH3
TK-X, TK3-1040
TH2b-123(R)
J0 1/J03
J03/J04