CHAPTER III

GEOLOGICAL SETTING

The Sirikit Oilfield is located in the central plain of Thailand. The field was discovered in 1981 and has an estimated STOIP (stock tank oil in place) of 350 million bbl and a recovery expectation of 41 million bbl of 40 API oil. The oilfield lies in the Phitsanulok Basin which is one of a series of Tertiary extensional rift basins in the northern part of Thailand that overlie the suture between the Shan Thai and Indochina cratons. The basin is 100 km wide and contains up to 8 km of Tertiary sedimentary rocks. The basin is surrounded by complex structures of deformed Paleozoic/Mesozoic rocks (WORKMAN, 1975; KNOX and WAKEFIELD, 1983). The tectonic history of the basin area is very complicated since the basin is situated in a triangular zone at the intersection of two regional strike-slip faults, the northwest-southeast-trending Mae Ping Fault Zone and the northeast-southwest-trending Uttraradit Fault Zone (FLINT et al., 1988) (Figure 6). The Sirikit field is located on the southern flank of the graben on a local basement high of this basin.

The geology of the oilfield is comprised of two major formation units, Lan Krabu Formation (interbedded sandstones, siltstones and claystones) and the partially

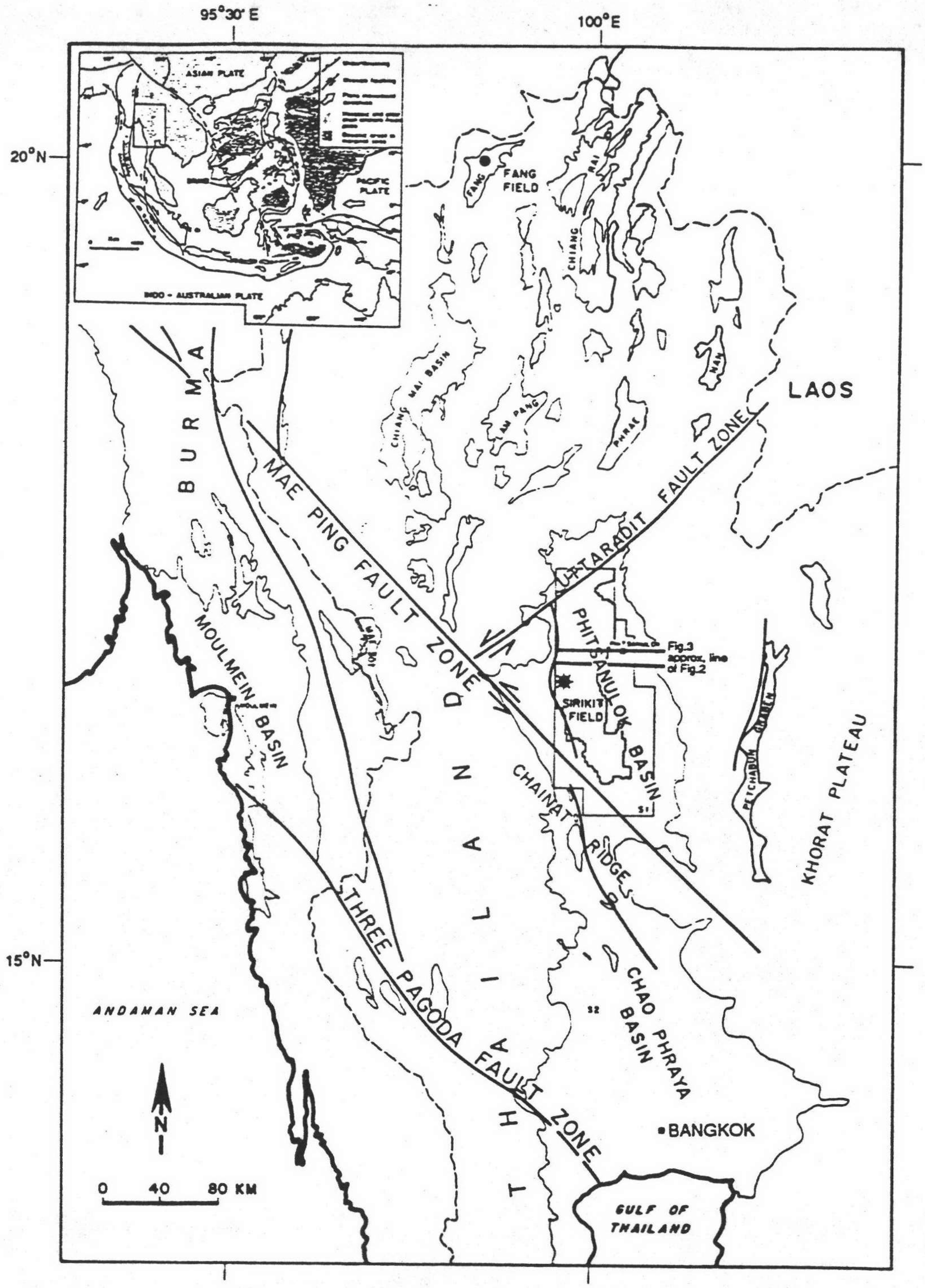
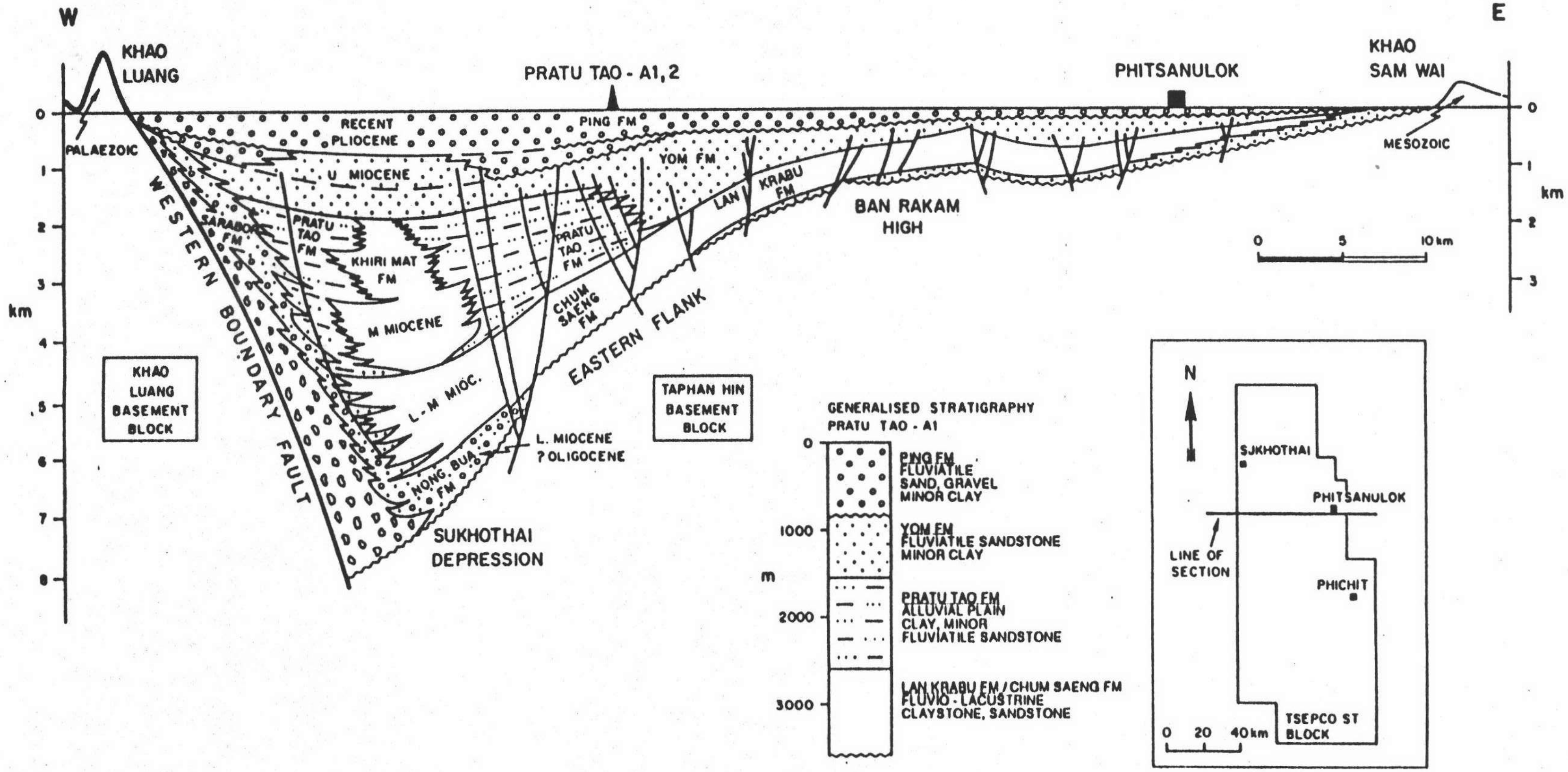


Figure 6. Regional structural framework of location map of Sirikit Oilfield, Phitsanulok Basin, onshore Thailand (from FLINT et al., 1988).



<u>Figure 7.</u> The stratigraphic cross section of the Phisanulok Basin
(from FLINT et al., 1988)

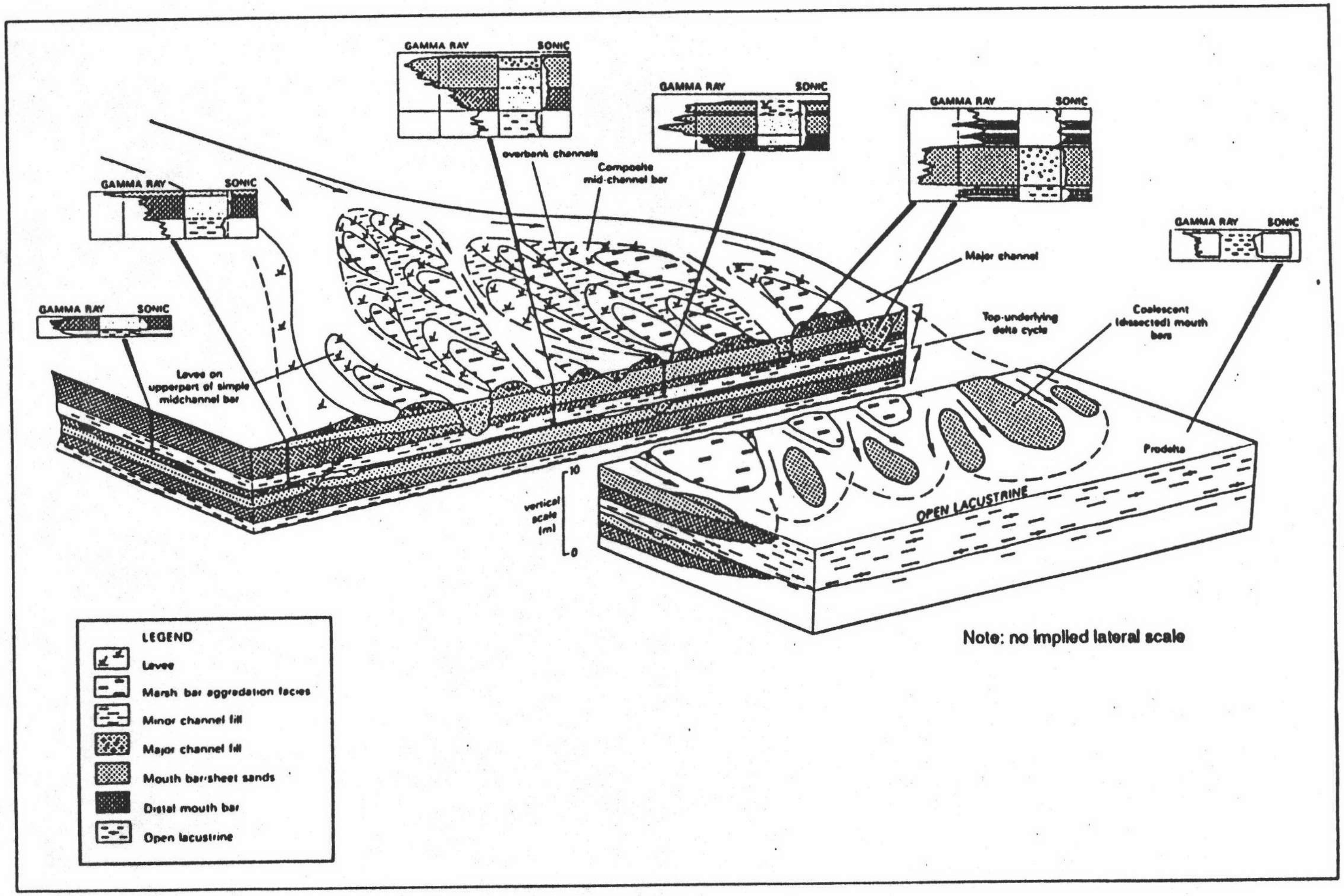


Figure 8. Deposition model of highly constructive lobate deltas of Lankabu Formation (from FLINT et al., 1988)

time-equivalent intercalated Chum Saeng Formation. It consists of organic-rich claystone containing a gastropod fauna found only in non-marine sequence. A lacustrine origin for the claystone is supported by palynofacies of detrital land-plant cast of fresh-water algae and no marine indicators. The Chum Saeng Formation acts as both source rock (to the north of the Sirikit field) and seal for this oil reservoir (Figure 7).

The Lan Krabu Formation, which is the oil reservoir, is divided into three reservoir units (K, L and M) separated and sealed by tongues of open-lacustrine claystones of the Chum Saeng Formation (FLINT et al., 1988). The claystone tongue seals are comprised of two lower intermediate units and one of the uppermost unit which acts as the main seal. For the K and L reservoirs, they are divided again into subunits or intervals originally based on gross petrophysical characteristic. The unit which is the main oil producing reservoir of this field is the K20 interval; whereas K10, K30 and K40 intervals have poor to intermediate quality. The subdivision of K sand reservoir (main reservoir) (FLINT et al., 1988) of Sirikit Oilfield is shown in Table 1.

The Sirikit Oilfield is comprised of three claystone facies. The most common facies association: the Lan Krabu Formation consists of a coarsening-upward regressive sequence starting with open-lacustrine claystone passing upward through delta-front sands and silts into a channel mouth-bar reservoir sandstone. The depositional model applicable to this oilfield is that based on high-constructive lobate (rather than elongate) delta (Figure 8). These delta types of depositional environments typically represent progadation of highly sediment-laden rivers into very shallow unstratified water bodies with relatively low wave energy. The variables which influence delta morphology in the subsurface during construction of the lobate Sirikit deltas (FLINT et al., 1988) are inferred to have included

- shallow, large lake
- mixed load rivers
- homopycnal flow
- minor wave energy
- highly variable river discharge rates
- poorly developed levees

Therefore, sheetlike sand bodies can be produced in fluvial dominated deltaic setting of this reservoir simply as a function of the evolutionary character of the fluvial system, without recourse to high basinal energy and sediment reworking. Early ideas on the development of the Phitsanulok Basin suggested negligible synsedimentary tectonics with minor strike-slip deformation occuring later (FLINT et al., 1988). However, conventional wisdom suggests extension may have been active until L reservoir times. Subsequent left-lateral wrench faulting took place during deposition of the K reservoir. Stacks of the composite mouth-bar sandstones, characteristic of the main producing K20 interval, may, therefore, reflect a subtle response to synsedimentary tectonism rather than simply punctuated subsidence episodes (FLINT et al., 1988).

The hydrocarbon accumulation of the Sirikit Oilfield is contained within the fluviolacustrine Lan Krabu Formation (KNOX and WAKEFIELD, 1983). The oil generation was suggested to occur at depths greater than 4,000 metre. Stacked hydrocarbon-bearing sand packages occur which are sealed by overlying and intervening massive lacustrine clays. This morphology is in contrast to conventional models for lacustrine-deltaic sedimentation (sheetlike rather than elongate sand stringer morphology) and has important implications for reservoir characterization and development. The oil which was suggested to have migrated to the Sirikit Field exhibits the following general properties (KNOX and WAKEFIELD, 1983):

Property	Range
°API gravity	38.2-41.2
Flash point (°F)	80-98
Kinematic viscosity (@ 122° F cst)	4.5-11.35
Paraffin wax content (%W)	14.5-20.8
Pour point (°F)	+90-+95
Asphaltenes (%W)	0.05-0.1
Sulphur (%W)	0.15-0.38

<u>Table 1.</u> Subdivision of K sand reservoir (main reservoir of Sirikit oil) in Lan Krabu Formation (from FLINT et al., 1988).

Subunit	Net/Gross (%)	Thickness (m)	Geology	Reservoir Quality
K10	5	20	Lacustrine shales/ thin sandstones	very poor
K20	25	60-80	Small deltas/well-drained flood plain claystones	good
K30	15	60-100	Very thinly bedded dry/wet flood plain claystones, channel	poor
K40	25	80-90	Deltas; thicker than in K20	good