CHAPTER 3

PETROLEUM POTENTIAL ASSESMENT IN THE NORTHERN PART OF THE WESTERN BASIN

Geochemical analysis

The potential source rock facies in the northern part of the Western basin is lacustrine facies of Oligocene to Early Miocene in age (Fig.2.2 a). However, the state of maturity of purposed active source rock facies has to be determined using the method of Lopatin.

Lopatin and many others belive that two factors, time and temperature, are important in oil generation and destruction. These two factors are interchangeable. A high temperature acting for a short time can have the same maturation effect as a low temperature acting over a long time. Lopatin assumed that the dependence of maturity on time is linear-doubling the cooking time that constant temperature doubles the maturity (Waples,1980). The conceptual framework can be summarized as follows:

A: The rate of the chemical reaction involed in thermal maturation of organic material appears to double with every 10°C rise in temperature.

B: Threshold values of Lopatin's time-teperature index of maturity are:

15 Onset of oil generation

75 Peak oil generation

160 End of oil generation

500 Up1per TTI limit for occurrence of oil with API gravity <40

1000 Upper TTI limit for occurence of oil with API gravity <50

C: TTI values calculated from Lopatin reconstruction consistently agree with orther maturation parameters commonly used by petroleum geologists.

The geological models were constructed using the information of the seismic section line BG 91-176 A (Fig 3.1 a) that made by GSI FAR EAST PTE LTD. The vertical scale of this line is 10 cm.:1 second and horizontal scale is 1 cm.: 10 shot points. This line is lie W to E and cross-cut the 6-1-C well. The time depth curve from well 6-1-C (AMOCO) was used as the reference to convert time to depth (Fig. 3.1 b) and the result can see in Table 3.1 a. The DIX program in the Hewlet Packard scientific calculator model HP-42S has been supported.

The DIX equation is as follow:

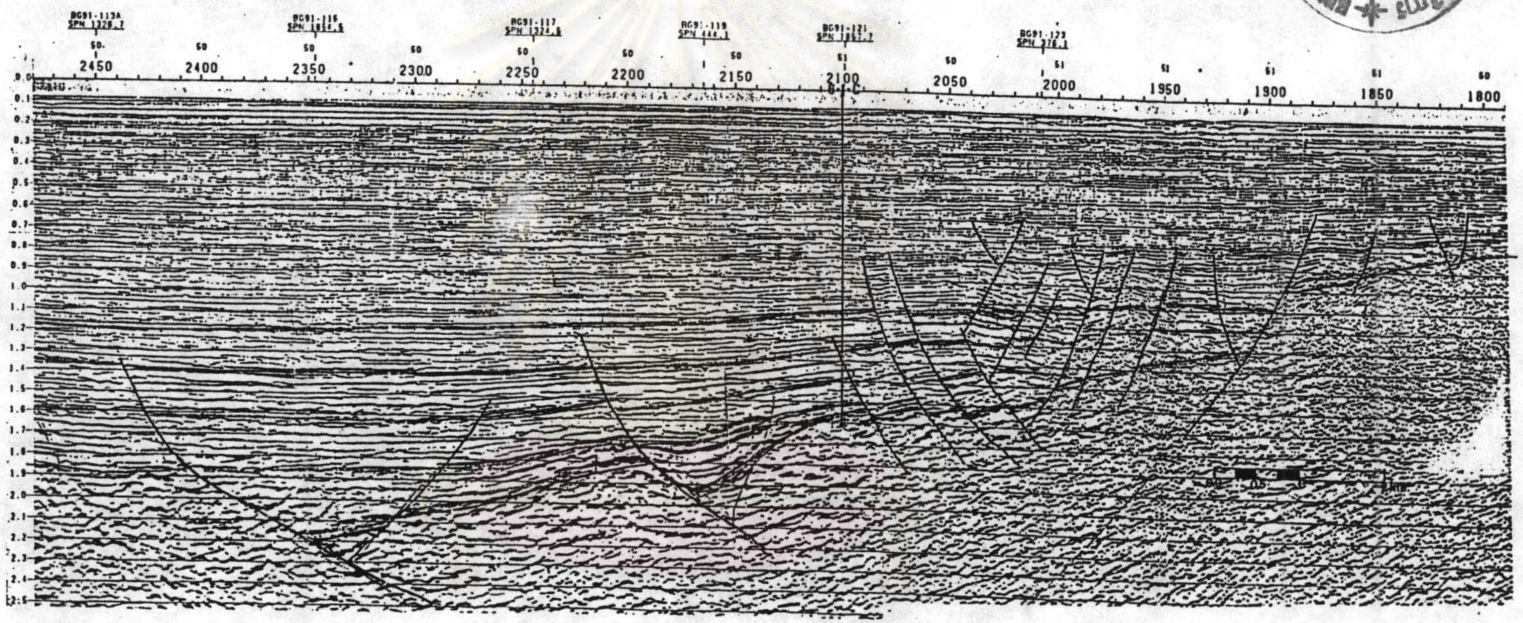

Figure 3.1 a Seismic section line no.91-176 A that shows the location of few shot points were selected to study.

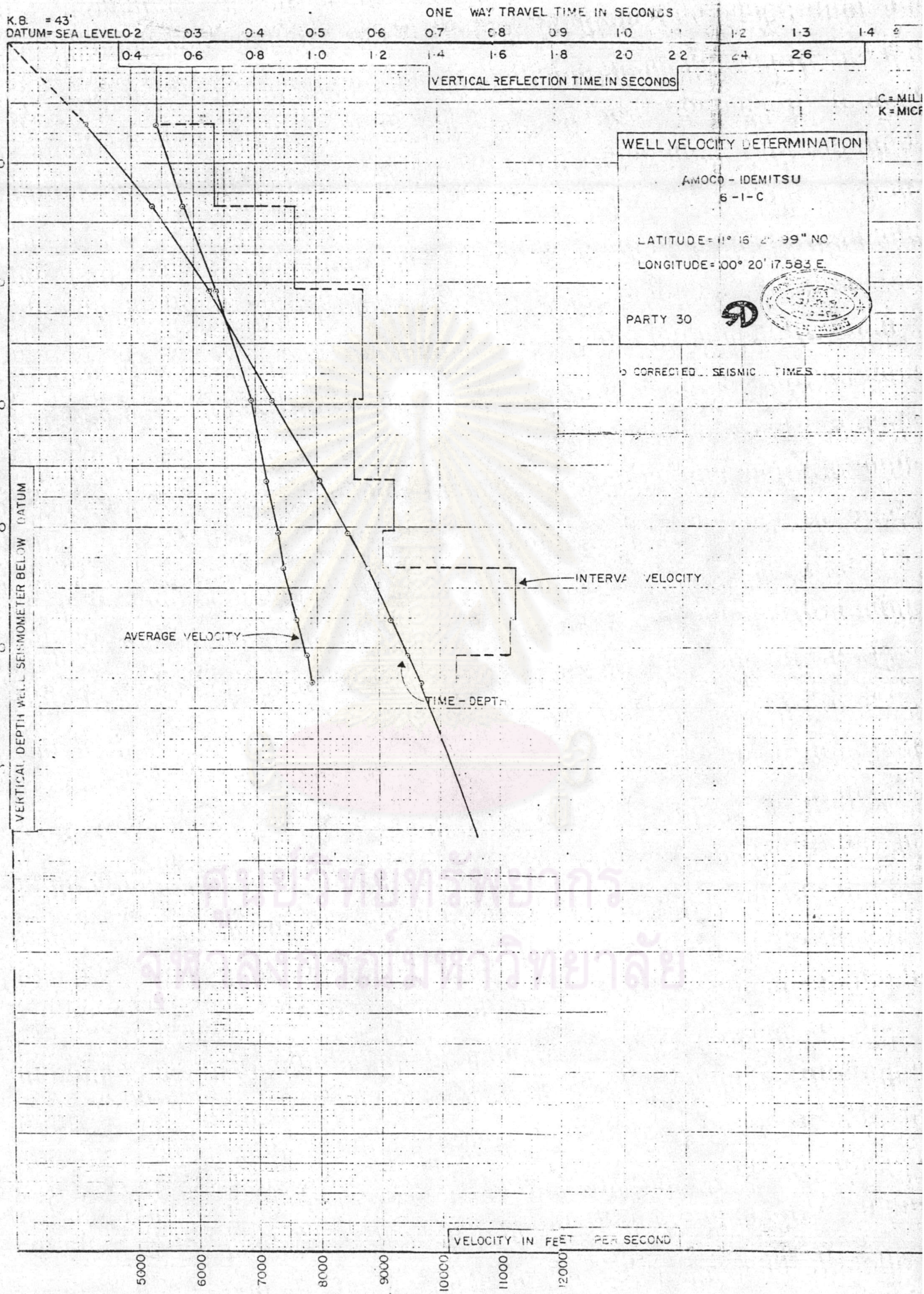

Figure 3.1 b Time Depth Curve of 6-1-C well (AMOCO)

Table 3.1 a The reslt of convert time to depth.

Shot Point	Horizon	Time (Sec.)	Depth (Mt.)
2,170	Top basement	1.92	2,919
	Base unit B	1.50	1,929
	Base unit C	0.97	1,039
	Base unit D	0.52	471
2,350	Top basement	2.2	3,369
	Base unit B	1.65	2,156
	Base unit C	1.04	1,130
	Base unit D	0.57	530

$VINT^2 = (VRM2^2 x T2 - VRMI^2 x T1)/(T2-T1)$

VINT= INTERVAL VELOCITY

T1 = UPPER TIME (TWO WAY)

T2 = LOWER TIME (TWO WAY)

VRM1= UPPER ROOT MEAN SQUARE VELOCITY

VRM2= LOWER ROOT MEAN SQUARE VELOCITY

The geological models for every horizon which is equivalent to the specific rock formation of the Northern part of the Western basin have been constructed using subsurface temperature, depth, and geologic time.The geothermal gradient of the Northern part of the Western basin measured from the 6-1-C well is about 4.21113^{0}C/100m. and the average surface themperature is 26 C. The velocity analysis is shown in Table 3.1 b and 3.1 c.The calculated results from these two geological models are summarized in Table 3.1 d and 3.1 e. The Two geological models are presented in Figure 3.1 c and Figure 3.1 d.

The TTI value indicates that the petroleum can be generated or petroleum generation phase has occured approximately since 11 Ma.. The source rock is the lacustrine sediments which are likely to be present in the lower part of the basin.

The result of the geochemical analysis from a very paraffin-rich crude obtained from 5714-5729 ft.

Table 3.1 b Velocity Analysis near shot point 2170

TIME (SEC)	Vrms (Mt/Sec)	Vint (Mt/Sec)	DEPTH (Mt)
0.01	1,500		0
0.08	1,511	1,513	53
0.432	1,750	1,800	370
0.810	2,023	2,296	804
1.336	2,427	2,943	1,577
1.761	2,987	4,296	2,490
2.454	3,824	5,396	4,360
3.202	4,065	4,771	6,144

Table 3.1 c Velocity Analysis near shot point 2350

TIME (Sec)	Vrms (Mt/Sec)	Vint (Mt/Sec)	DEPTH (Mt)
0.01	1,500		0
0.08	1,511	1,513	54
0.422	1,743	1,794	360
0.826	2,026	2,285	821
1.407	2,418	2,886	1,659
2.090	3,065	4,087	3,054
2.684	3,819	5,732	4,757

Table 3.1 d TTI values of the northern part of the Western basin at shot point 2170 on seismic section line no.91-176 (see Fig.3.1 a for location)

Temperature (^0C)	Interval Time	Temperature Factor	Interval TTI	Total TTI
Top of Basement				
20-30	1.25	0.003906	$4.87x10^{-3}$	$4.87x10^{-3}$
30-40	3.12	0.007813	$2.44x10^{-2}$	$2.92x10^{-2}$
40-50	3.12	.015625	$4.87x10^{-2}$	$7.80x10^{-2}$
50-60	3.12	0.31250	$9.74x10^{-2}$	$1.75x10^{-1}$
60-70	3.01	0.062800	$1.88x10^{-1}$	$3.64x10^{-1}$
70-80	2.67	0.125000	$3.33x10^{-1}$	0.697
80-90	2.67	0.250000	$6.67x10^{-1}$	1.364
90-100	2.67	0.500000	1.334	2.698
100-110	3.40	1.000000	3.399	6.098
110-120	4.18	2.000000	8.362	14.459
120-130	4.03	4.000000	16.116	30.575
130-140	2.52	8.000000	20.167	50.743
140-150	2.25	16.00000	35.975	86.718

Temperature (^0C)	Interval Time	Temperature Factor	Interval TTI	Total TTI
Base B				
20-30	1.067	0.007813	$4.169x10^{-3}$	4.169x10
30-40	2.668	0.007813	$2.084x10^{-2}$	2.501x10
40-50	2.668	0.015625	$4.169x10^{-2}$	6.670x10
50-60	2.668	0.031250	$8.338x10^{-2}$	1.501x10
60-70	3.654	0.062800	$2.284x10^{-1}$	3.785x10
70-80	4.181	0.125000	$5.226x10^{-1}$	9.011x10
80-90	3.748	0.250000	0.937	1.838
90-100	2.521	0.500000	1.260	3.099
100-110	1.823	1.000000	1.823	4.921

Table 3.1 e TTI values of the northern part of the Western basin at shot point 2350 on seismic section no.90-76 (see Fig.3.1 a for location)

Temperature (^0C)	Interval Time	Temperature Factor	Interval TTI	Total TTI
Top of Basement				
20-30	1.018	0.003906	$3.977x10^{-3}$	$3.977x10^{-3}$
30-40	2.545	0.007813	$1.988x10^{-2}$	$2.386x10^{-2}$
40-50	2.545	0.015625	$3.977x10^{-2}$	$6.363x10^{-2}$
50-60	2.545	0.031250	$7.953x10^{-2}$	0.143
60-70	2.545	0.062500	$1.591x10^{-1}$	$3.022x10^{-1}$
70-80	2.478	0.125000	$3.097x10^{-1}$	$6.119x10^{-1}$
80-90	2.314	0.250000	$5.786x10^{-1}$	1.190
90-100	2.314	0.500000	1.157	2.348
100-110	2.314	1.000000	2.314	4.662
110-120	2.314	2.000000	4.629	9.291
120-130	3.911	4.000000	15.645	24.936
130-140	3.958	8.000000	31.663	56.599
140-150	3.194	16.00000	51.098	107.697
150-160	2.240	32.00000	71.690	179.387

Temperature (^0C)	Interval Time	Temperature Factor	Interval TTI	Total TTI
Base B				
20-30	0.926	0.003906	3.616×10^{-3}	3.616x10
30-40	2.314	0.007813	1.808×10^{-2}	2.17x10
40-50	2.314	0.015625	3.616×10^{-2}	5.786x10
50-60	2.314	0.031250	7.233×10^{-2}	1.302x10
60-70	2.445	0.062800	1.528×10^{-1}	2.830x10
70-80	3.958	0.125000	4.947×10^{-1}	7.777x10
80-90	3.958	0.250000	0.989	1.767
90-100	3.008	0.500000	1.504	3.271
100-110	2.240	1.000000	2.240	5.512
110-120	1.521	2.000000	3.042	8.554

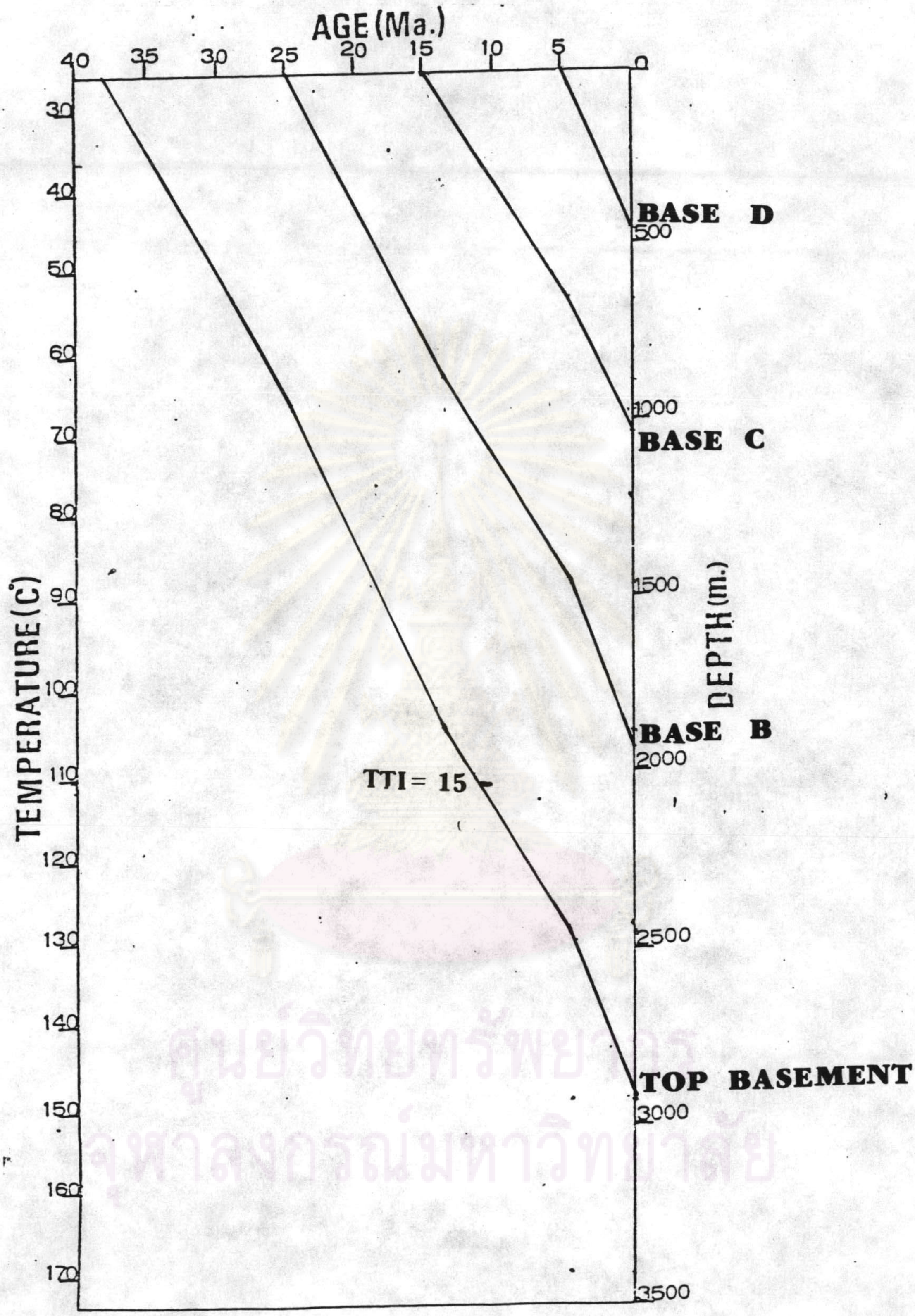

Figure 3.1 c Burial History graph of the northern part of the Western basin at shot point 2170.

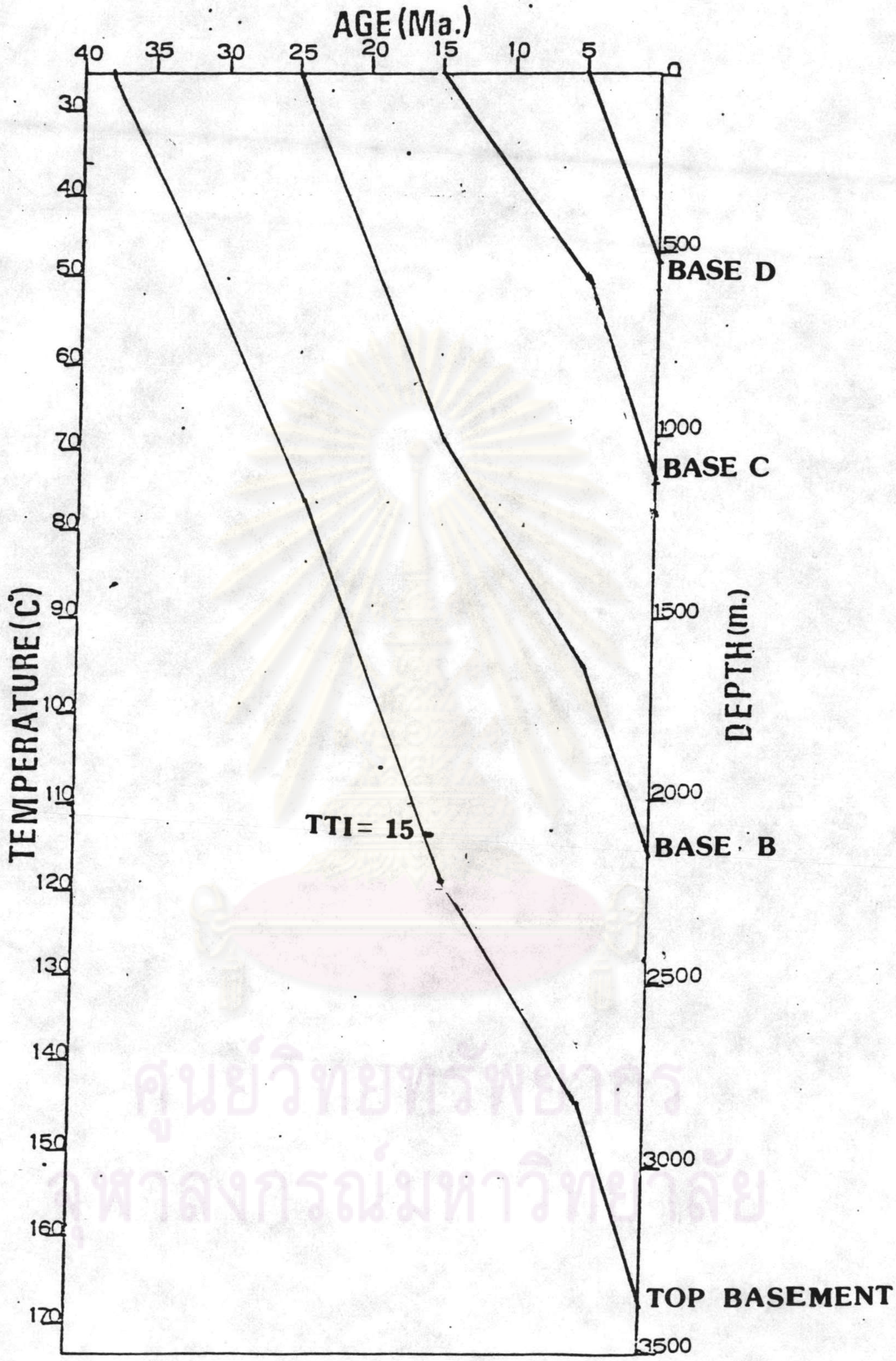

Figure 3.1 d Burial History graph of the northern part of the Western basin at shot point 2350.

taken sand of presumed Miocene age was submitted for oil correlation. This paraffin-rich oil is solid at room temperature.

Amoco 6-1-C oil is correlative with the unaltered type II Gulf of Thailand crude. Geochemical data such as infered spectra type B, and pristane/phytane ratio suggest correlation with type II oil.

Hydrocarbon prospective evaluation

1. Source rock

The result of the study from well logs of the 6-1-C well shows that little sorce rock in Early Miocene age. But from seismic lines and B5 /27-1 well shows that Western basin contains a source rock, which is lacustrine origin in Oligocene age. The Oligocene lacustrine environment is expected to be shale dominate with only minor sand development. The B4/27-1 well in the Kra basin tested a thick shale section with TOC's of over 5%. A similar environment of deposition and hence lithology is anticipated in the Western basin.

The result from TTI indicates that the source rock of this basin commenced maturation around 7 Ma.. The geothermal gradient in this area is quite high.

In the Kra and Chumphon basins, thick lacustrine sequences exist in the deeper parts at approximately 1,200 and 1,000 metres respectively. Geochemical analysis of the claystone from B4/27-1 well that carried out by BP indicates average TOC as high as 5.19% by weight and average source potential for hydrocarbon generation as high as 12.43 kg/ton (Lekuthai,1991)

Evidence from seismic data suggests lacustrine claystones also appear to be present in the northern part of the Western basin.

2. Reservoir

Trevena and Clark (1986) summarized the Miocene sandstone resoirvoirs from gas field in Pattani basin as being rapidly declinning in porosity and permeability with increasing burial depth. This decline results from rapid burial diagenesis. That is related to very high geothermal gradient in the basin.

Flint et al. (1989) proposed that the lacustrine deltaic sedimentation of Sirikit oil field in the Pitsanulok basin is a regressive cycle of coarsening upward sequence. The cycle is fluvial dominated deltas prograded into a large relatively shallow lake. The deltas have a sheet like geometry due to a combination of high frictional forces related to similar river and lake water densities and the shallow large lake with variable fluvial sediment load.

Burri (1989) also mentioned about the reservoir sandstone in the Cenozoic intermontane basin in Thailand. there are of limited lateral extent and most of them contain lithic fragment, partly of unstable mineralogy because of the high tectonic activity along the rift, which load to uplift and erosion of the basin flank and accompanied by young volcanism.

Sandstone of unit B and the Pre-Tertiary carbonates are considered as two prime reservoirs in this area. The sandstone have been deposited by fluvial and lacustrine environments.

BG Co. penetrated sections in this basin indicate that these sandstone posses good porosity at shallw depth of less than 2500 metres. Porosity appears significant with depth. Below 2500 metres, this becomes a problem with resoirvoir quality.

The Pre-Tertiary carbonates have been proven to have good reservoir units with high oil production rates in the Nang Nuan field, Chumphon basin. Generally, lost circulation has occured in such carbonates drilled by wells in the area. This suggests that karstification and fracturing were extensively developed prior to the deposition of the Tertiary. There is a high tendency of second porosity in the carbonate basement.

3. Seal

From stratigraphy of well 6-1-C unit A and B are the most effective hydrocarbon seals. They contain claystone seal interbedded with the sandstone reservoir. The claystone in the units are thicker compared to the C and the unit D as it deposited in the shallow to deep lacustrine environment.

4.Trap

In general most extensional rift basins form structural traps such as anticlinal and fault closures. The structural traps in the Northern part of the Western basin are small anticline,fault closure or a combination of anticlinal fault trap.