CHAPTER 1: INTRODUCTION

1.1 GENERAL INFORMATION

Sarawak has an area of about 124,000 km^2 which is almost equivalent to the total area of the other 11 States forming the Peninsular Malaysia. Located immediately north of the Equator between latitudes 0°50'N and 5°N and Longitudes 109°36'E and 115°40'E, Sarawak stretches over 700 km along the northeastern coast of the Borneo Island (Fig. 2). Inland, the boundary between the Kalimantan, Borneo is formed by watershed dividing those rivers flowing southerly direction into Java and Celebes Seas. Sarawak is separated from the Peninsula Malaysia to the West by about 600 km of water and it is directly adjoined to the State of Sabah to the Northeast where the Sultanate of Brunei also forms a double enclave.

Sarawak is a tropical country with an equatorial climate. It experiences two monsoonal changes. The Northeast Monsoon which usually occurs between November to February brings heavy rainfall and the period is locally referred to as the *Landas* season. The Southwest Monsoon is usually less wet.
Except for the monsoonal changes, the climate conditions remain fairly stable throughout the year.

The big rivers draining Sarawak are namely the Kayan, Sarawak, Lupar located in the west Sarawak region and the Rajang, Baram and Limbang, located in the central and north Sarawak regions. Rajang river is being the longest river both in Sarawak and Malaysia (Fig. 3).

The study area, the Northwest Borneo Basin is located in NW Sarawak is covering both the onshore and the offshore areas.

1.2 GENERAL GEOLOGY

The geology of Sarawak is recognised as belonging to three distinct provinces, corresponding to three main geographic regions, namely West Sarawak, Central and North Sarawak (Fig. 4).

West Sarawak is that part of the state south and west of Lupar River, mainly underlain by the Early Cretaceous Melange and in places underlain by Tertiary sedimentary basin and Tertiary intrusives.

Central Sarawak is that part of the state north and east of Lupar River, extends northeast to the watershed dividing Rajang River from Baram River. Central Sarawak is underlain by a very thick, tightly folded turbidite, the Rajang Group.

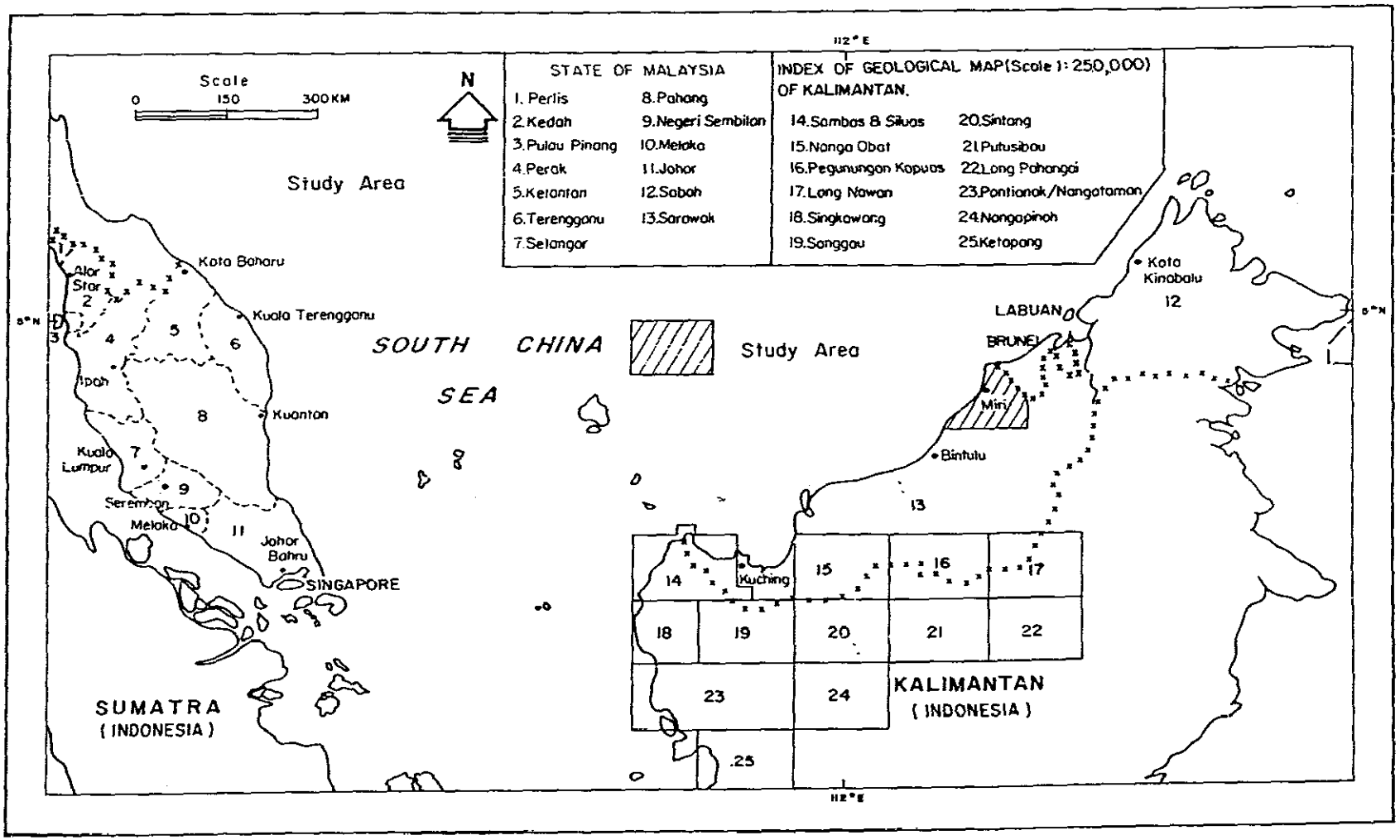

Figure 2. Location map of the study area

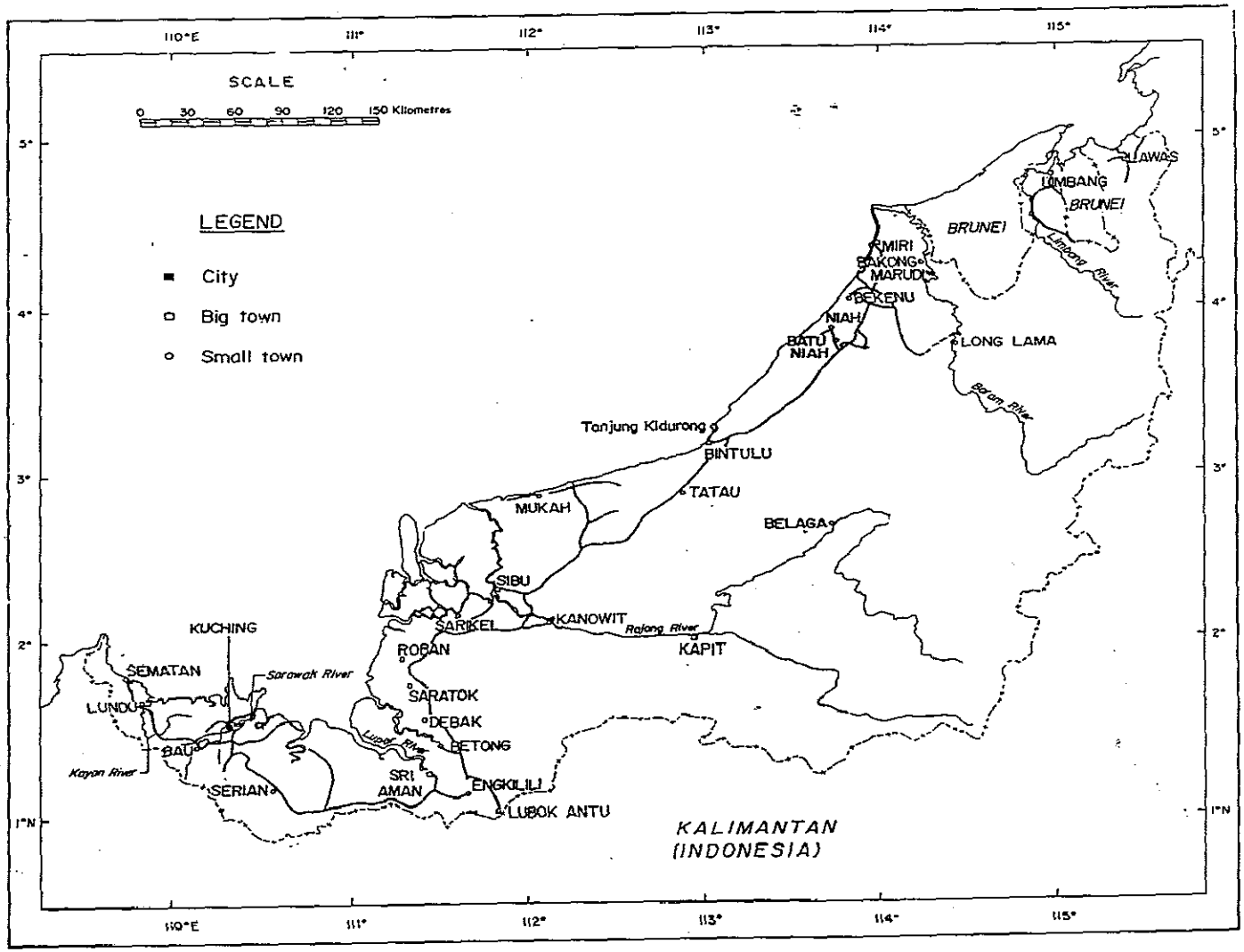

Figure 3. Town centres and rivers of Sarawak

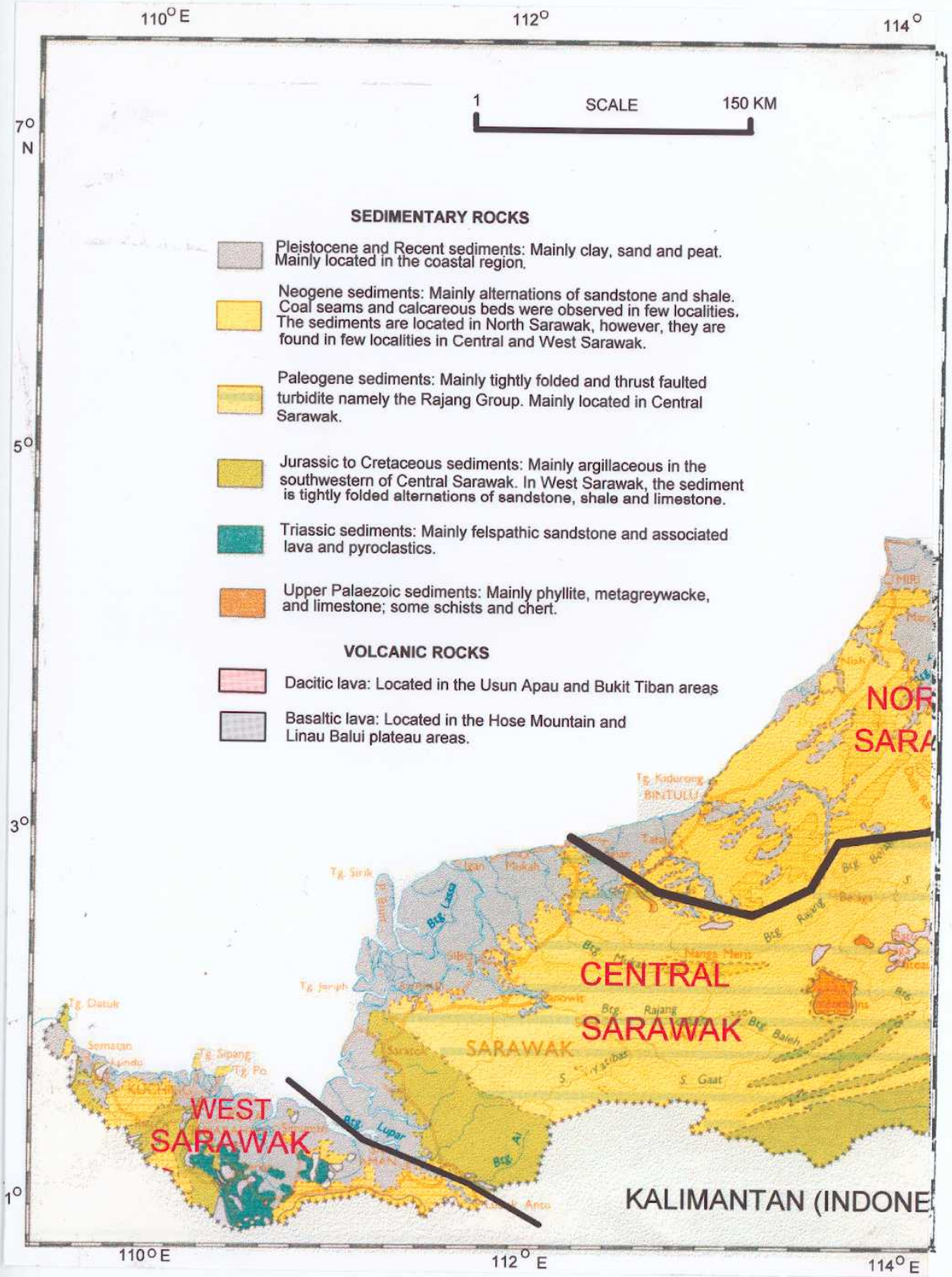

Figure 4. Geological map of Sarawak (modified after Hon, 1992)

North Sarawak is the region north and east of the Rajang-Baram watershed. In offshore area, this region is named as Luconia Block (Hutchison, 1989) where there are many hydrocarbon deposits have been located by Sarawak Shell Oil Company since early 1950's. The area is underlain by the Neogene sediments. The study area is located onshore of this region.

1.2a West Sarawak

West Sarawak, is made up of Early Cretaceous Melange, and in places is underlain Tertiary sedimentary basins, and also intruded by Tertiary intrusives. The melange is consisting of Sarawak block, shallow to deep marine sedimentary rocks and underlying ophiolitic rocks. Sarawak block which is occurring as a broken rock formations, is emplaced chaotically within the tightly folded and faulted sedimentary rocks of Late Jurassic to Cretaceous age. Sarawak block is made up of schist, limestone and volcanic rocks and respectively were formerly named as Tuang schist (Hon, in manuscript), Terbat Formation and Serian Volcanics (Liechti, et al, 1960). The tightly folded and faulted sedimentary rocks of the melange are mainly the alternations of shale and sandstone, limestones, and respectively were formerly named as the Pedawan Formation and the Bau Limestone Formation (Liechti, et al, 1960).

This region is rich in economic minerals such as gold, silver and bauxite.

1.2b Central Sarawak

Central Sarawak is underlain by a very thick, tightly folded turbidite, the Rajang Group which was formerly described as the basal part of the Northwest Borneo Basin. The turbidite which is estimated 10 km (33,000- 35,000 feet; Liechti et al, 1960) thick is younging towards the north. They are mainly the alternations phyllite and slate interbedded with sandstone of the Layar Member of the Belaga Formation; is Late Cretaceous in age. Located further in the north are mainly the alternations of shale and sandstone of the Belaga Formation, is Paleocene to Eocene in age. Fossils are rarely observed in this turbidite.

However, in places the turbidite is overlain by the Tertiary sedimentary basin such as the Nyalau Formation. The formation is consisting mainly conglomeratic sandstone and alternations of thick beds of sandstone and shale, is Miocene in age.

The igneous rocks such as gabbro and basalt are located at the base of the turbidite in the Lupar valley. These igneous rocks are ophiolitic and are Cretaceous in age (Tan, 1979). In the eastern part of central Sarawak, volcanic rock such as basalt formed extensive plateaus, whereas in the northern part, granophyre, andesite and rhyolite are forming the mountain ranges.

1.2c North Sarawak

This region is underlain by Neogene sediments of the NW Borneo Basin. The sediments are younging towards North and NNE with their bases are Oligocene in age, are gradually younging into Pliocene towards offshore. However, the youngest sediment ever recorded in the onshore region is Mid Miocene.

The offshore area is underlain by mainly sandstone, shale and limestone. Based on sedimentology and paleontology, eight sedimentary cycle units were established (Ho, 1978, Fig. 2, p. 3) with their bases comprise of marine clay which is gradually coarsening upwards into the alternations of sand and clay. They were many petroleum deposited have been located and exploited in this region.

1.3 PREVIOUS INVESTIGATION

The geological investigations of the Northwest Borneo Basin or North Sarawak as accounted by Liechti et al (1960), was started as early 1880's when several oil companies particularly Sarawak Shell Oil Company started the exploration for petroleum in the onshore area. Later, after 1950 the search for petroleum deposit was extended to the offshore areas. However, later investigation in the onshore was mainly to locate the potential area for mineral (Wilford, 1961; Haile, 1962). Recently, however, the geological investigation was conducted in more specific manner, such as the study of the planktic foraminifers in the onshore areas of the North Sarawak (Banda, 1994, 1995a).

Liechti et al (1960), described the region was underlain by thick sequences of shallow and deep marine sediments, characterized by the sandy formations and the shaly formations respectively. The formations are namely: the Nyalau, Setap, Tangap, Sibuti, Belait, Lambir, Miri and Tukau Formations with their ages ranging from Oligocene to Pliocene (Fig. 5). The Nyalau, Belait, Lambir, Tukau and Miri were described as shallow marine to deltaic sediments and contained rare planktic foraminifers. The Setap, Tangap, Sibuti Formations contained some planktic foraminifers, were deposited in the open marine environments. Based sedimentary structure, fossil content and lithology, North Sararawak was interpreted by Liechti et al (1960) as a sedimentary basin that had undergone a rapid deposition due to subsidence or escalation of water levels.

After 1950, Sarawak Shell Berhad extended their exploration activities for petroleum to the offshore regions particularly in Baram Delta area. They were extensive drilling and geophysical surveys were carried out in the area. As a result, detailed subsurface geology of Baram Delta was formulated; consisting mainly coarse clastics transported from Baram River. However, they were few

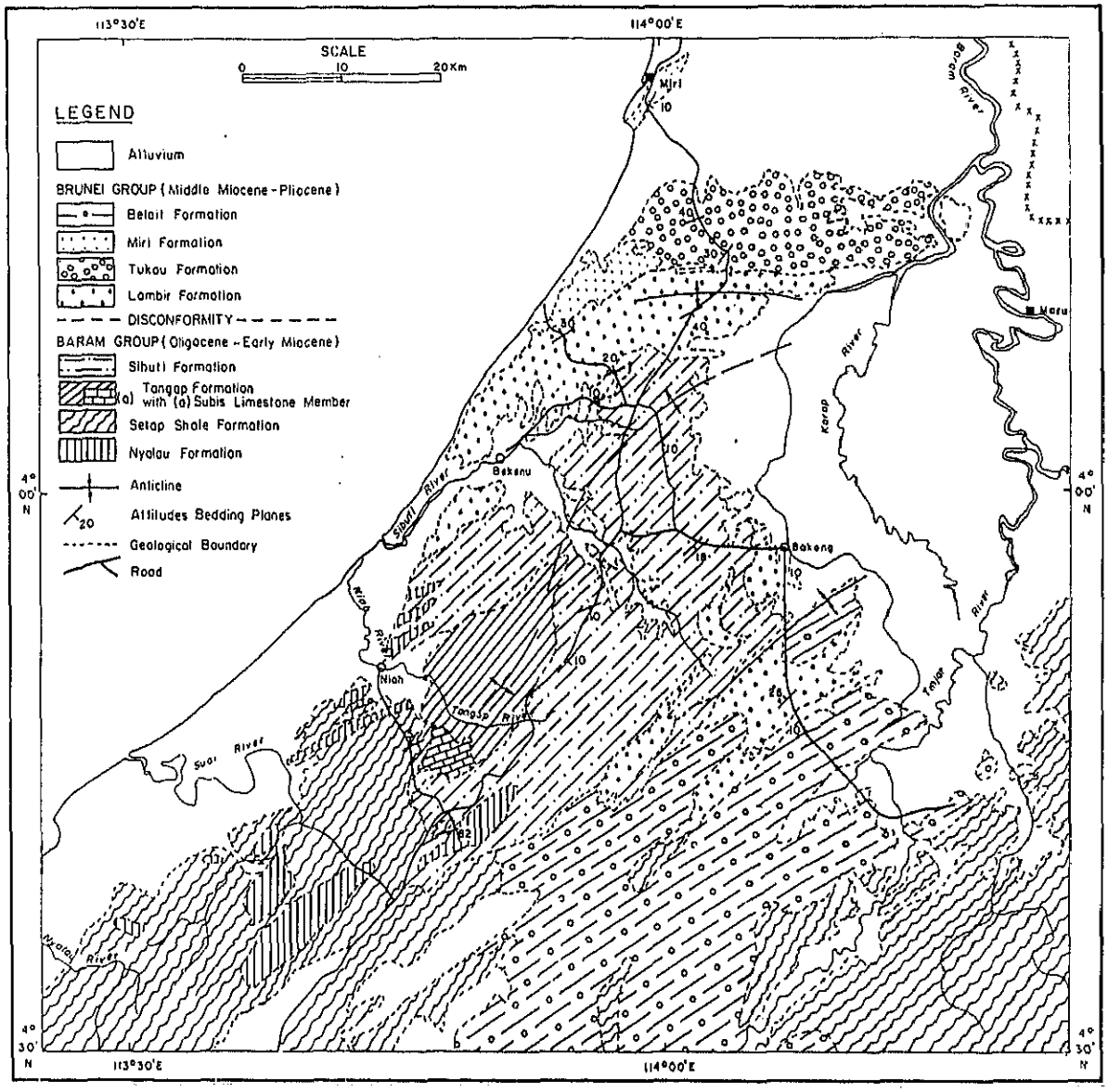

Figure 5. Geological map of the Northwest Sarawak (after Liechti et al, 1960)

layers of marine clay intercalated among the coarse clastics. Based on sedimentology, paleontology and geophysical logs, the offshore region is made up of 8 sedimentary cycles of transgressive sequences of the clastics with few localities of carbonate built-up (Fig. 6). The cycle units were deposited through Paleogene to Neogene (Ho, 1978). Each sedimentary cycle is characterized with a deposition of a marine clay which is gradually coarsening upwards into alternations of sand and clay sequence.

The previous investigation on planktic foraminifers or Foraminifera in general was very minimal. However, Liechti et al (1960), described the occurrences of planktic foraminifers in the Sibuti and the Subis areas, but they did not provided a species name list and also but did not used the fossil for the age assignment. They, instead used larger Foraminifera such as *Lepidiocyclina* sp., *Myiogypsinoides* sp., and *Spiroclypeus* sp. to assign Miocene age for the sediments in Subis area, because the importance of the planktic foraminifers as a tool in biostratigraphy was the beginning, not be able to convince most of the biostratigrapher at that time.

In 1970s and 1980s, the application of planktic foraminifers proved its importance particularly for the deep marine sediments. In offshore of NW Sarawak, planktic foraminiferal biostratigraphy zonation was developed together with other zonations such as pollen, larger foraminifera and geophysical log (Fig. 7). The age of the offshore sediments based on the age of the zone is Late Oligocene to Miocene.

Recently, R. M. Banda (1994, 1995a) studied planktic foraminifers from Miri - Tinjar Road section and the Sibuti area in attempt to assign the age of the sediment and also to establish a proper stratigraphic framework of the Northwest Borneo Basin. The investigations showed that the age of sediments in the studied areas is Early Miocene to Mid Miocene deposited in a shallow open marine.

1.4 OBJECTIVE OF PRESENT INVESTIGATION

Since the last systematic geological investigation of Liechti et al (1960), there is no systematic geological mapping was carried in North Sarawak or Sarawak as a whole. Later investigation was only focussed on certain subject, such as mineral exploration, quarry investigation and engineering geology.

In the onshore area, the marine sediments were described to contain a lot of planktic foraminifers but there is no systematic study was undertaken as yet. However, in the offshore area, the planktic foraminiferal zonation was established by Ho, 1978, but there is no detailed description of type section and the type species.

The main objectives of the present investigation are therefore:

1) to describe the geology of Sarawak focussing on the stratigraphy of the

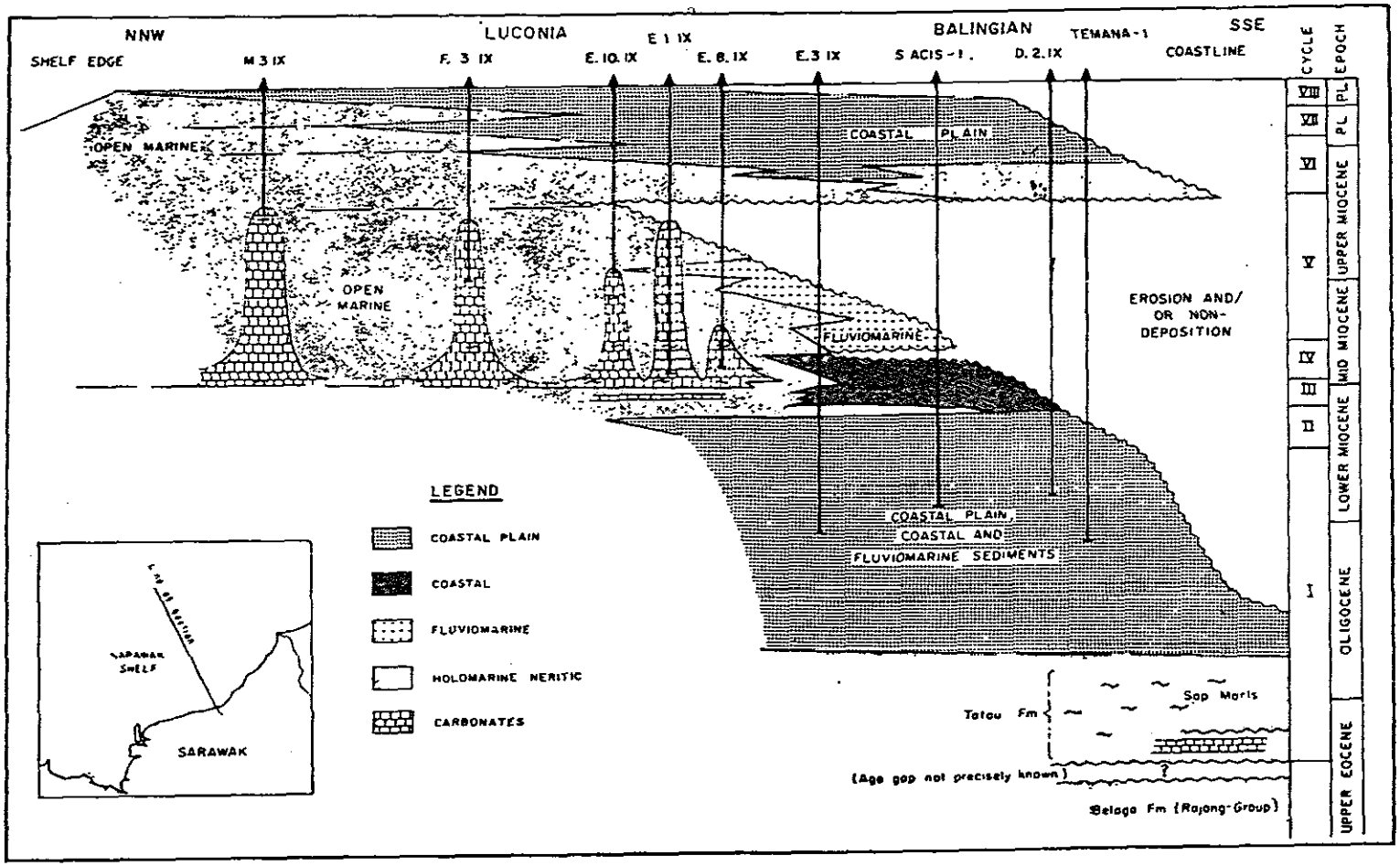

Figure 6. Stratigraphical section across the central Sarawak (after Ho, 1978)

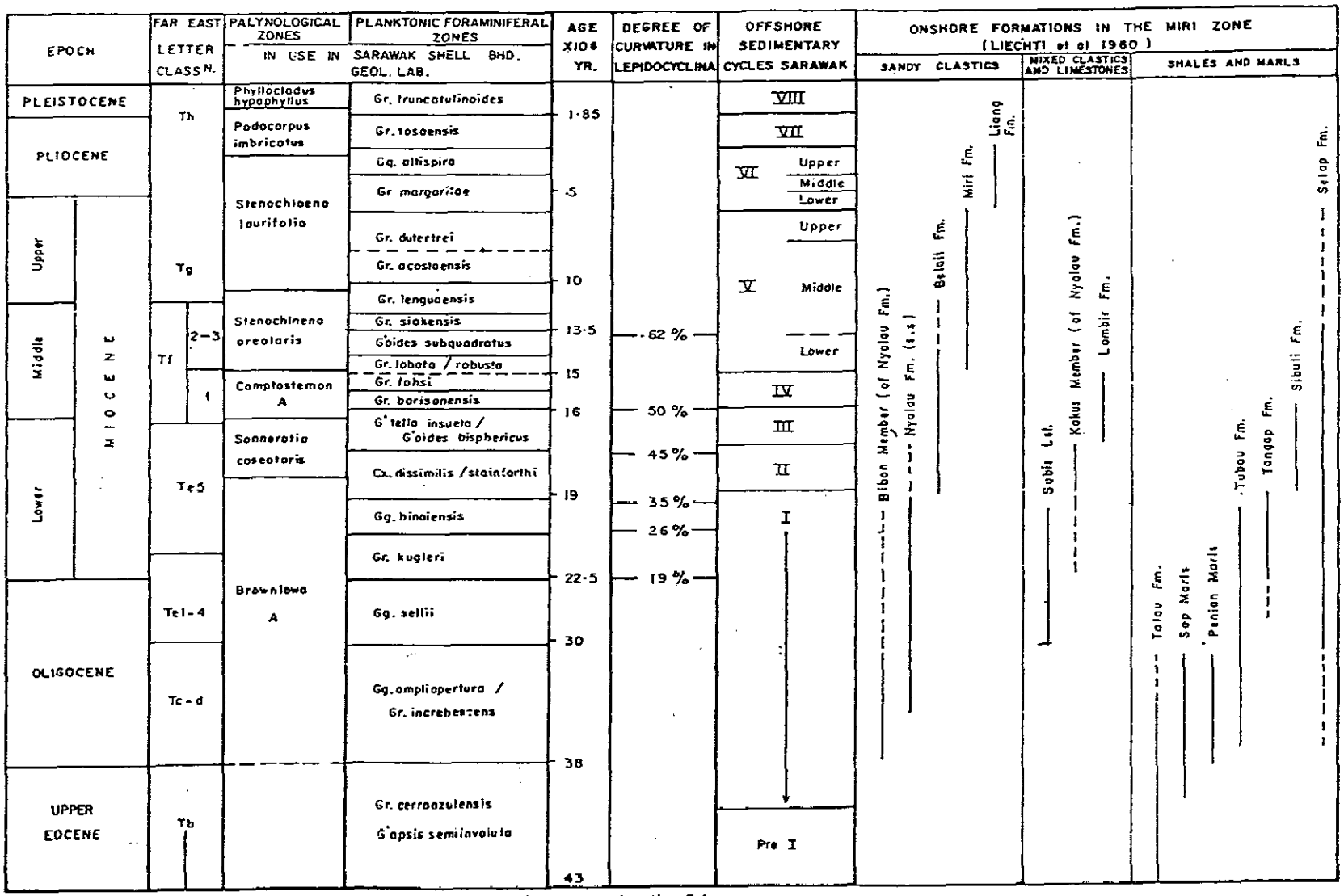

Figure 7. Stratigraphic subdivision and paleontological zonation in the Tertiary of Sarawak (after Ho, 1978)

Northwest Borneo Basin with the current concept of geotectonic and the stratigraphic nomenclature as stipulated by the International Subcommission of Stratigraphic Classification (ISSC), 1994.

2) to establish the planktic foraminiferal biostratigraphic zonation of the Northwest Borneo Basin and undertake correlation with other areas of the region,

3) to construct a model of the geological evolution of the area based on present geological data such as geotectonic, lithostratigraphy and biostratigraphy.

With the success of this investigation, a proper and formal stratigraphic framework will be established and this will enhance the exploration for minerals in the area.

In order to achieve the objectives, the scope of present investigation is systematically subdivided into 4 chapters of approach; i) Geotectonic Framework, ii) Geological Mapping, iii) Planktic Foraminiferal Biostratigraphic zonation and correlation and iv) Geological evolution (Fig. 8).

THE GEOLOGY AND PLANKTIC FORAMINIFERAL BIOSTRATIGRAPHY OF NORTHWEST BORNEO BASIN, SARAWAK, MALAYSIA

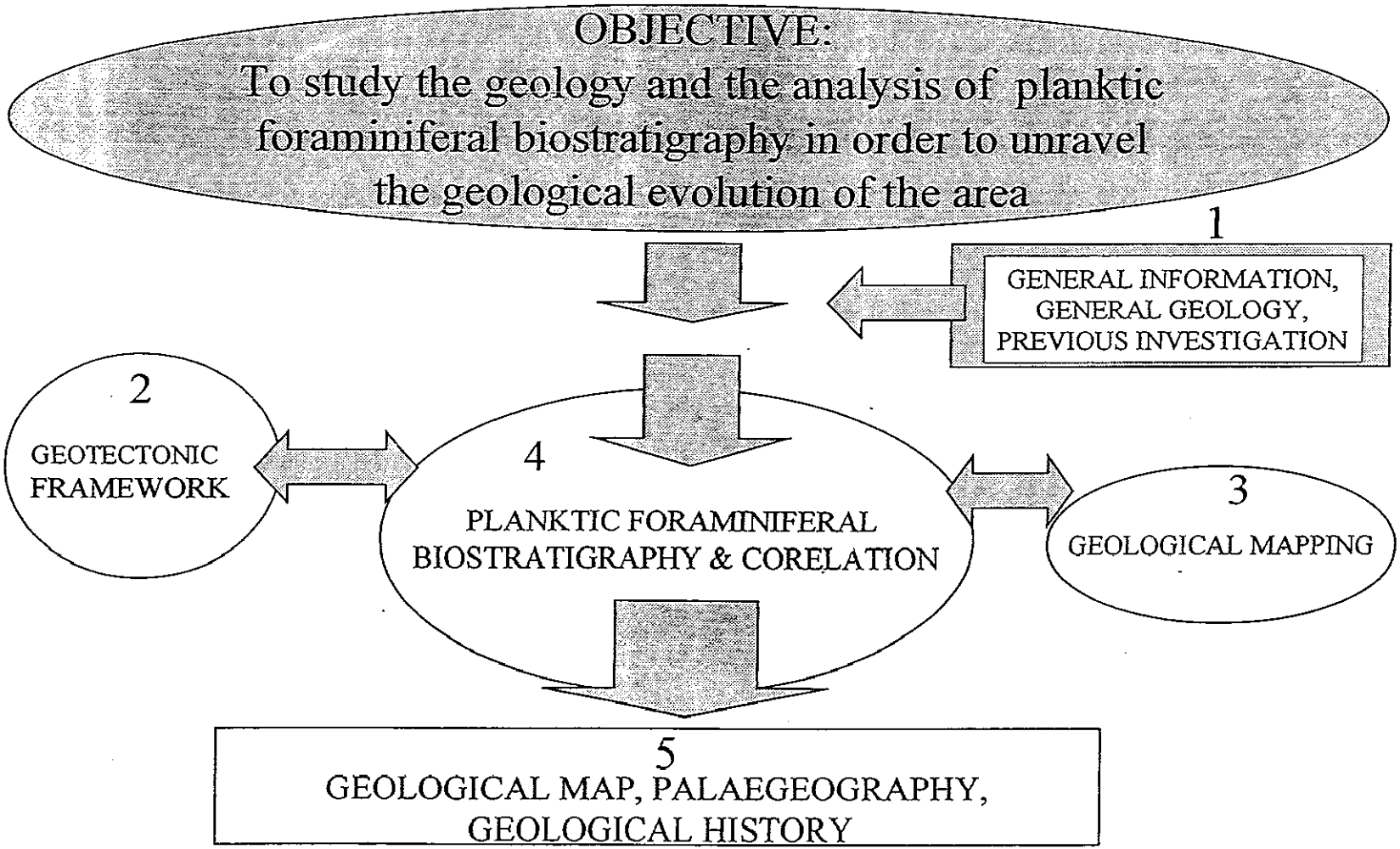

Figure 8. Workscope of the present investigation