CHAPTER IV

GEOMORPHOLOGY INVESTIGATION

The knowledge about the landform and associated natural processes it is essential in a landslide study as certain landforms are more susceptible to a slope movement due to their nature of development and stage of evolution than the others. The study of geomorphology reveals the knowledge of past and present earth processes, geomorphic surface and physical properties of the underlying materials that vary from place to place. These thus help predicting the areas which are susceptible to landsliding and identifying the controlling environmental characteristics of the known landslides (Cook, 1974). In the study, the concept of classifying distinctive landforms help recognizing and identifying the nature of landslides and consequently, the recognition of the present or future slope movement in terms of type and causes is important for the prevention or correction of such failure (Harold and Liang, 1978).

In this study, an air-photographic interpretation of regional and areal scales plus the field investigations were carried out as follow.

4.1 Air-Photographic Interpretation.

The interpretation of air-photographs has been proved to be an effective technique for recognizing and delineating the landslide. According to Harold et al. (1978), the usage of air-photographic

interpretation for landslide investigation include those following.

a) Identification of vulnerable locations.:

Typical vulnerable locations that can be recognized in air-photographs include areas of steep slope, cliff or banks being undercut, areas of drainage concentration, seepage zones, areas of hummocky ground, and areas of fracture and fault concentration.

b) Identification of active and inactive state of existing landslides.

The careful study of sequential photography lead to the evaluation of the state of activity of existing landslides.

c) Identification of boundaries of existing landslides.

Boundaries of existing landslides can readily be delineated in air-photographs.

In the present study, an air-photographic interpretation was carried out on black-and-white vertical stereoscopic air photographs which were taken in 1953 and 1974. The interpretation technique used was referred to as pattern analysis of Harold et al. (1978). These patterns are topographic expression, drainage, erosion, soil tones, vegetation and culture. The air photograph of approximately scale 1:50,000 and 1:15,000 were interpreted for regional and detailed information. The detailed air-photographic interpretation map of this study area of embankment failure is presented in Figure 4.1.

The results of air-photographic interpretation and data gathered from field observation reveal that Khao Samo Phun is a

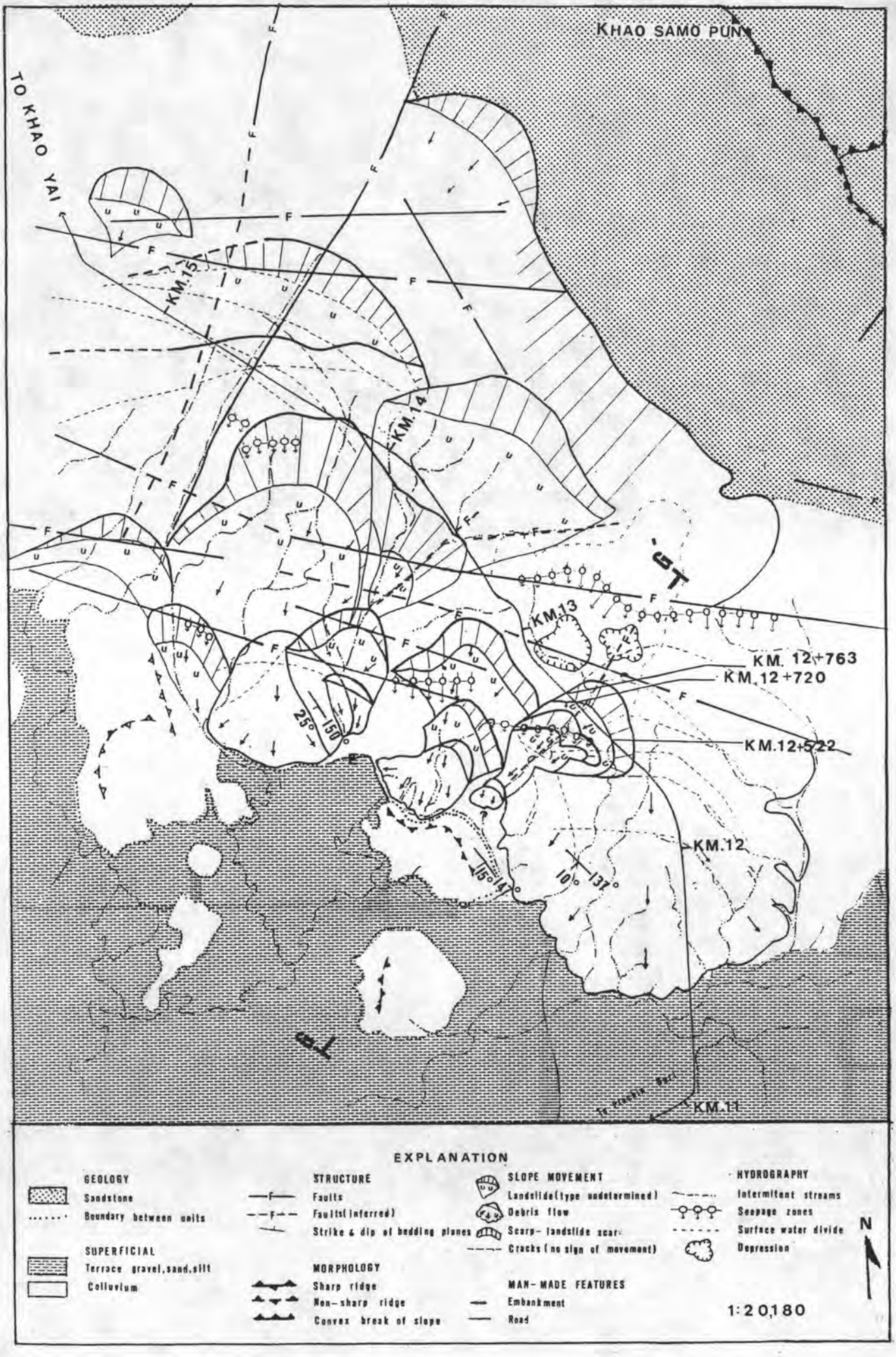


Figure 4.1 Air-photographic interpretation map of the study area of embankment failures.

gentle cuesta of Phra Wihan sandstone. Weathering and mass wasting produce a colluvial deposit at the base of the back slope of this mountain. In the upper part of this colluvial mass, the evidence of past movement with the long major scarps or landslide scars of large ancient landslides were observed. There are five groups of existing natural landslides located at the central portion of this colluvial mass. Most of these common landslides are "debris slides" and "debris flow". Debris flows usually occur at the lower portion of these debris slides and extends over to the alluvium, down below.

At the study area of embankment failure, KMs. 12.653 to 12.765, the highway between KM.'s 12.410 and 12.765 was constructed across an existing natural landslide scar. Above and below this scar, seepage zones were observed. The drainage pattern and density of drainage channels suggest that above this existing landslide scar, there is a recharge area with catchment zone of 0.42 square kilometers. The surface water discharged from the seepages at a higher attitude together with the rain water accumulate in the topographic depressions within this recharge area. The groundwater appears again as the series of seepages at and below the embankment failure locations as well as along the nearby gully course.

4.2 Geomorphology Investigation Along Prachinburi-Khao Yai Area.

According to the air-photographic interpretation plus the field regional geomorphological data, a regional geomorphological map along Prachinburi-Khao Yai area was constructed. The geomorphological map is to illustrate the landform and the nature of the underlying materials of both bedrocks and superficial materials, and to indicate

the kind and magnitude of the geomorphological processes having been and being occurred in the area (Cook, 1974).

Geomorphically, the landforms were classed into five main groups. Their aerial extent are shown in Figure 4.2. The groups of landforms and their characteristics are described below.

4.2.1 Units of fluvial origin.

The area of fluvial sediments are observed in the southern part of the study area. This unit is further divided into 4 subunits as followed.

4.2.1.1 Recent flood plain.: The subunit comprised of natural levee and back swamps occurs along the Nakhon Nayok and the Prachinburi rivers.

4.2.1.2 Low terrace.: This subunit appears as a low lying flat terrain with the slope less than 2 degrees and composed of silty clay and clayey fine sand According to Thiramongkol (1983b), the age of this low terrace is late Pleistocene.

4.2.1.3 Middle terrace.: The middle terrace of middle Pleistocene age (Thiramongkol, 1983b) composing of clayey and silty sand mainly lies between 3 to 15 meters above the Mean Sea Level (MSL) with the relief of 2 to 4 meters forming a gentle undulating surface. Laterites are present occasionally.

4.2.1.4 High terrace.: The Pliocene to Early Pleistocene (Thiramongkol, 1983b) high terrace forms a strongly undulating eroded surface. The subunit lies between 10 to 21 meters

FIGURE 4.2

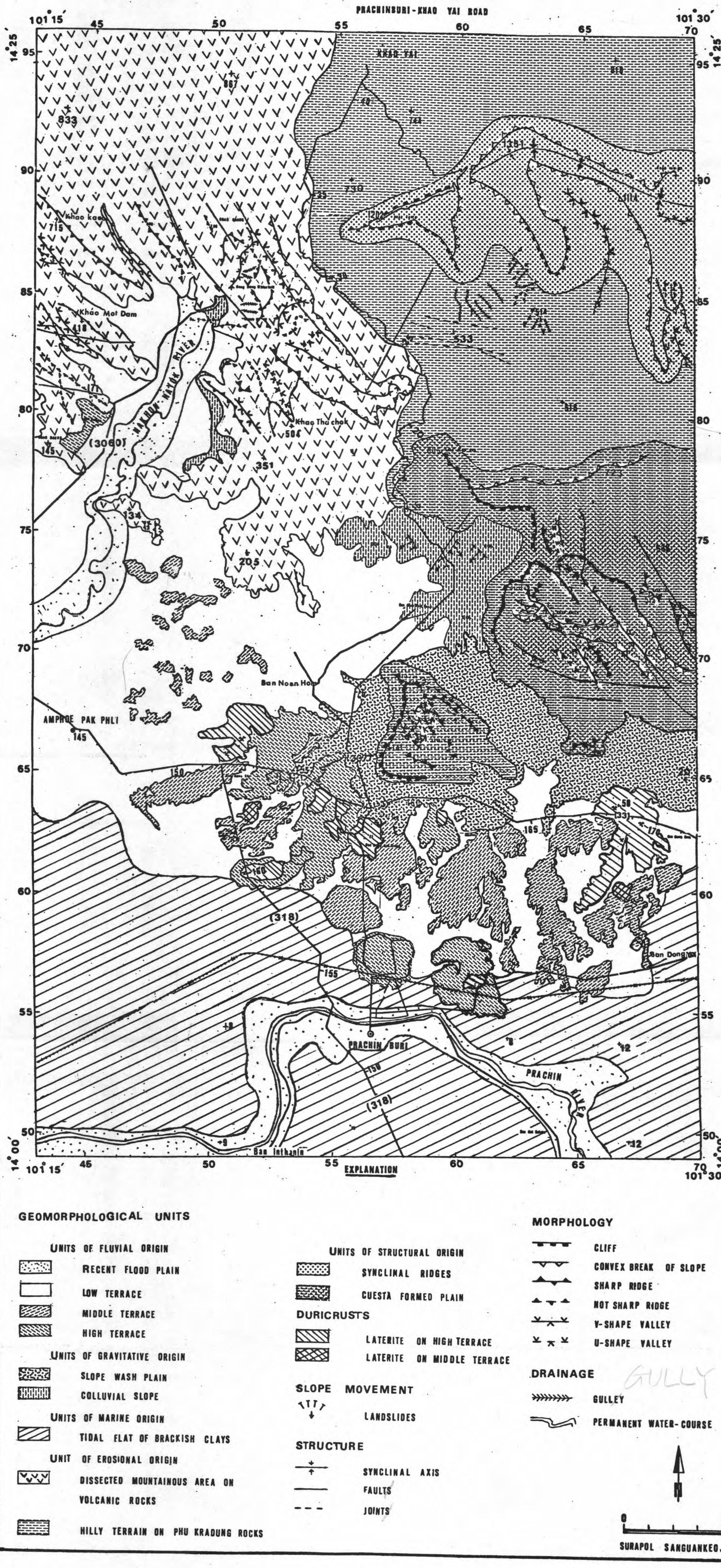


Figure 4.2 Geomorphological map of an area Prachinburi - Khao Yai highway.

above the mean sea level with a relief of 12 to 40 meters and consists of clayey and silty sand deposits with some laterites.

4.2.2 Units of gravitative origin.:

This unit is composed of the weathering products of Phra Wihan sandstone which deposited at the foothill. This unit is subdivide into 2 subunits.

4.2.2.1 Slope wash plain.: The subunit comprises the sediments transported by surface water and accumulated at the foot of Khao I To and Khao Khieo. The deposit consists mainly of silty fine sand.

4.2.2.2 Colluvial slope.: The deposit composing of gravelly clayey fine sand accumulated on the gently slopes beneath the cliffs and sharp ridge of Khao Samo Phun. The existing natural landslide scars were observed in this colluvial mass.

4.2.3 Units of marine origin.

4.2.3.1 Tidal flat of brackish clays.: This lower Holocene marine sediments form an extensive low-lying flat terrain, 2 to 3 meters above the mean sea level (Thiramongkol, 1983b). It is predominately composed of dark to black clays of the brackish water origin (Takaya, 1971). This marine sediments were observed in the southern part of the study area.

4.2.4 Units of erosional origin.:

This unit of landforms located in the mountainous zone in the northern portion of the study area. It is divided into 2

subunits as follow.

4.2.4.1 Dissected mountainous area on Volcanic rocks.: This subunit consists of Khao Yai Volcanic rocks. It lies between 40 and 1142 meters above the mean sea level, and is characterized by the highly dissected ridge-and-valley erosional landforms.

4.2.4.2 Hilly terrain on Phu Kradung rocks.: This subunit is composed of soft mudstone and siltstone of Phu Kradung Formation and lies between 400 and 800 meters above the mean sea level. Geomorphologically these rocks form the denudational hills.

4.2.5 Units of structural origin.

This unit is the mountainous terrain on Phra Wihan sandstone. It lies between 400 and 1351 meters above the mean sea level. This unit is divided according to the structural pattern into 2 subunits.

4.2.5.1 Synclinal ridges.: The resistance sandstone beds form the escarpments with gentle dip slopes, and a broad synclinal ridge plunging northwestward. The axis of the synclinal structure locates to the northeast side of Khao Khieo.

4.2.5.2 Cuesta formed plain.: The cuesta plains of resistance sandstone were found on Khao I To and Khao Plai Lam Katuk.

4.3 Detailed Geomorphologic investigation of the Area of Embankment Failures.

The detailed geomorphologic investigation is necessary for a landslide study. The landforms and geometry of the slopes should be

analysed as the steep slopes are the most vulnerable locations of failure, i.e. landslide is common in some landforms and rare in others.

The colluvium is easily identified in an air-photograph as bare slopes in the mountaineous area, however they are not so obvious as marked by the vegetated lower slopes (Harold et al., 1987). The thick young colluvium deposits also have a distinctive shape in plane and section which can be recognized in air-photographs. The common shapes in plane are lobes, lenses or fans, but may sometimes be uniform blankets. The old deposits often have a boulder-strewn surface resulting from erosion of the fine matrix (Huntley and Randall, 1981).

In this study, detailed geomorphologic investigation was done by air-photographic interpretation of approximate scale 1:15,000 plus field visits.

From the study, it was found that the embankment failures locate along the existing natural landslide scars, in the colluvial mass below the escarpment of Khao Samo Phun. The contact between this deposit and sandstone bedrock can easily noticed as break of slope (Figure 4.3).

According to a nine-unit landsurface model (Figure 4.4) proposed by Dalrymple (1968). The landsurface in this study area is a part of the upper portion of colluvial footslope in unit 6 (Figure 4.5a). The slope angle of this colluvial deposit varies from 6 to 10 degrees, but at the site of embankment failure the slope inclination changes to about 26 degrees (Figure 4.5b, 4.6).

The slope angles being obtained in this study is also explicitly consistent with the slope angle of a failed colluvial slope theorized by Gray (1971).

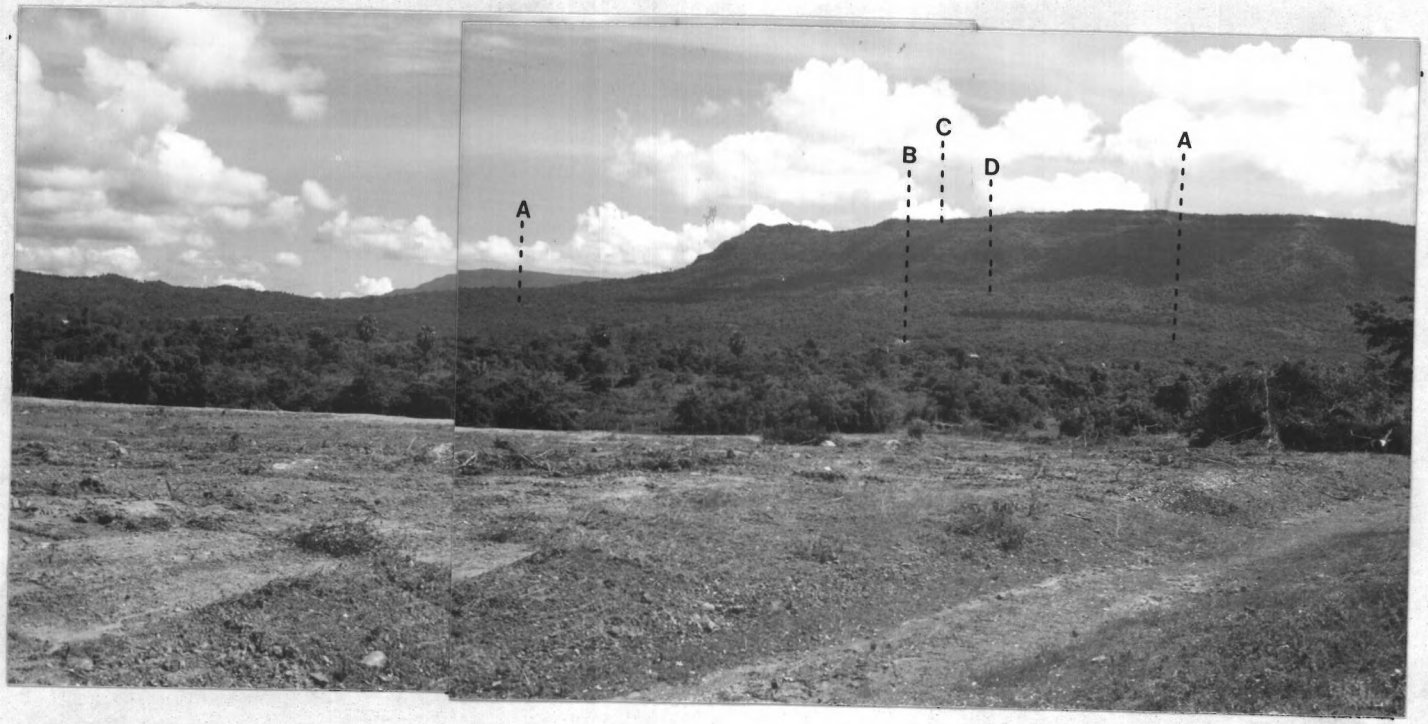


Figure 4.3 Scenery of the study area of embankment failures.

A - Colluvium; B - Slide area; C - Khao Samo Phun;

D - Break of slope

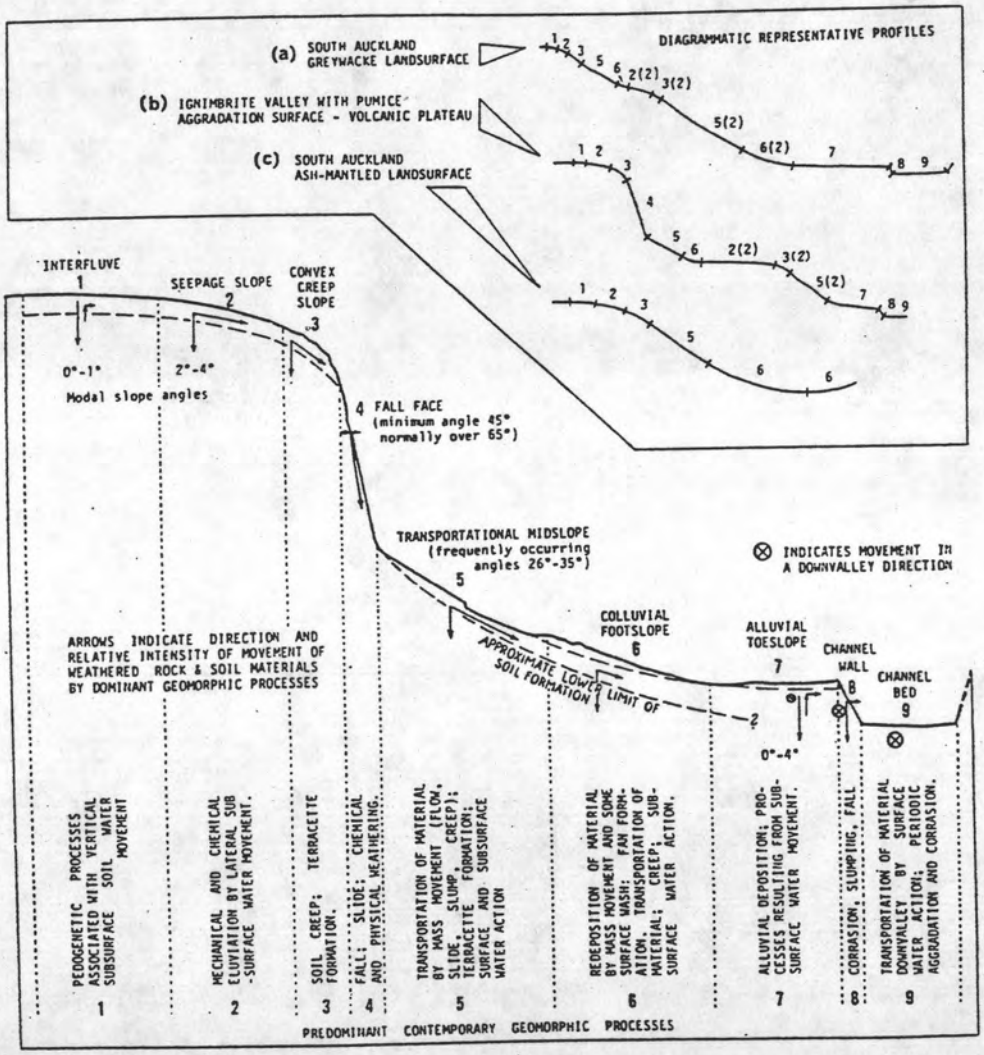


Figure 4.4 Diagrammatic representation of the hypothetical nine unit landsurface model. (After Dalrymple et al, 1968.)

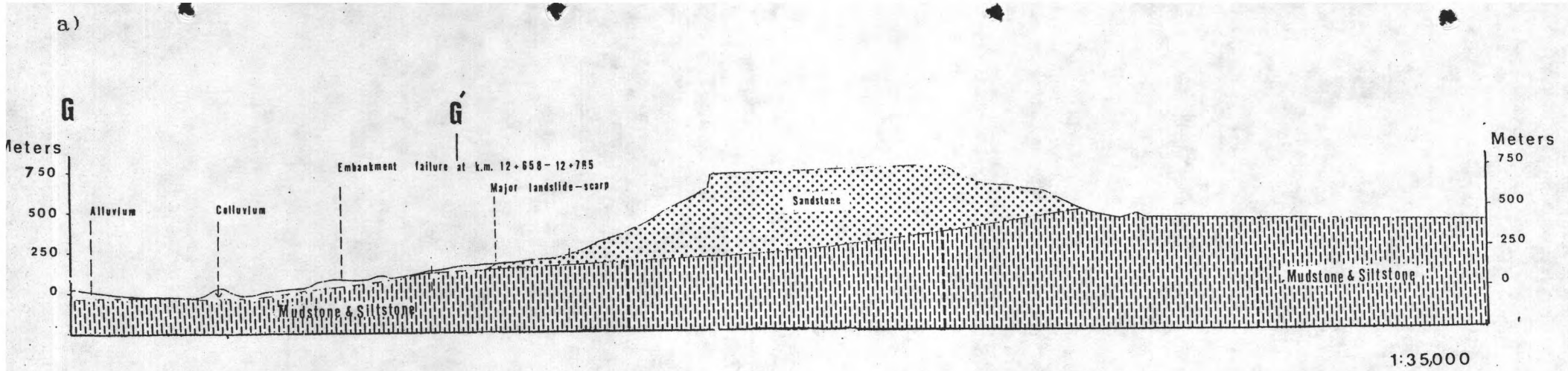
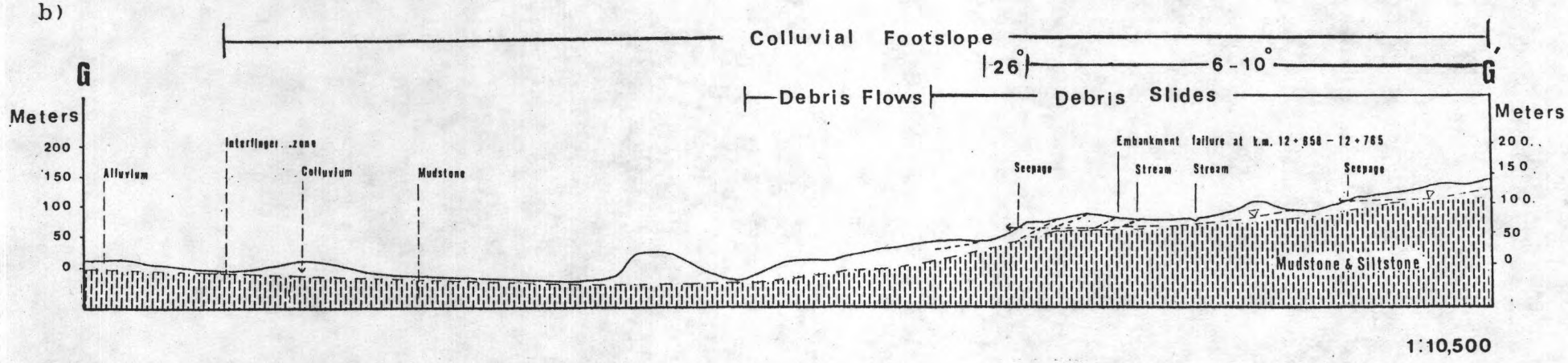


Figure 4.5(a) Cross - Section showing the landform in the study area of embankment failures with the location of colluvial foot slope.



(b) Cross - Section along G - G'(in Fig. 4.5a) showing the type of landslides, slope geometry, and drainage ways of seeped water.

Figure 4.6 Gentle slope of colluvial deposit at the base of Khao Samo Phun.

A - Gentle slope; B - Khao Samo Phun;

C - Colluvium