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GEOLOGY OF THE MARIKINA FAULT ZONE, METRO MANILA, PHILIPPINES

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ABSTRACT. *The Marikina Fault zone is a group of major geologic structures in the Greater Manila Area (GMA) which controls the morphology of the Marikina Valley and the course of the Marikina River from Montalban in the north to Pasig in the south. Several secondary faults or fracture systems can be observed traversing the main faults. In the mapped area, the Marikina Fault zone consists of several parallel faults and the most predominant are two normal faults, the West Marikina Valley Fault (WMVF) and the East Marikina Valley Fault (EMVF). The WMVF is a continuous structure which can be traced from the north in the vicinity of Montalban to the town of Pasig in the south. In contrast, the EMVF is discontinuous in the southern part of the valley (Marikina-Pasig).*

Three lithologic units are present in the local mapping area. These units consist of the Upper Miocene Alagao Volcanics, Pleistocene Guadalupe Formation, and Quaternary Alluvium. The existence of significant geological structures such as the Marikina Faults may have varying influences on the horizontal and vertical spatial distribution of these stratigraphic units.

INTRODUCTION

The study area is considered part of the southeastern edge of the Luzon Central Valley basin. It is believed to be underlain by a basement of Late Cretaceous Ophiolites covered by a sequence of Paleogene to Neogene and Pleistocene sedimentary pile aggregating to a 14 km thickness (Bachman *et al.* 1983). The Marikina Fault zone is composed of several geologic structures in the Marikina Valley at the eastern edge of Greater Manila area (GMA). Geologic studies indicate that the study area is controlled by two fault systems : the East and

West Marikin Valley Faults. Movements along these faults strongly influenced the morphology and exerts effects on the horizontal structure. It is in fact a group of major geologic structures in the Greater Manila Area (GMA) which controls the morphology of the Marikina Valley and the course of the Marikina River from Montalban in the north to Pasig in the south. Several secondary faults or fracture stystems can be observed traversing the main faults. In the mapped area, the Marikina Fault zone consists of several parallel faults and the most predominant are two normal faults, the West Marikina Valley Fault (WMVF) and the East Marikina Valley Fault (EMVF).

The WMVF is a continuous structure which can be traced from the north in the vicinity of Montalban to the town of Pasig in the south. In contrast, the EMVF is discontinuous in the southern part of the valley (Marikina-Pasig).

LOCATION

The areas of investigation are the municipalities of Pasig, Marikina, San Mateo, Montalban and Quezon City; all in the Metro Manila and Rizal Province (Fig. 2). These occupy a narrow north-northeast - south-southeast trending rectangular strip. It is bound by latitudes 14° 34' to 14° 44' and longitudes 121° 03' to 121° 09'

The latest movement of the Marikina Valley Faults gave rise to the present landforms in the study area. It can be divided into three contrasting physiographic features : 1) the upland west of the Valley, 2) Marikina Valley, and 3) the mountainous area east of the Marikina Valley (Fig. 1). The upland is bounded on the east by the West Marikina Valley Fault and underlain by tuffaceous rocks while the Marikina Valley is covered by Quaternary Alluvium and delta deposits. The third physiographic feature is bounded on the west by the East Marikina Valley Fault and is underlain by basalt.

STRATIGRAPHY

Figure 3 shows the composite stratigraphic column of rock units exposed in the study area. Three lithologic units are present in the local mapping area, viz; the Alagao Volcanics, Guadalupe Formation and the Quaternary Alluvium.

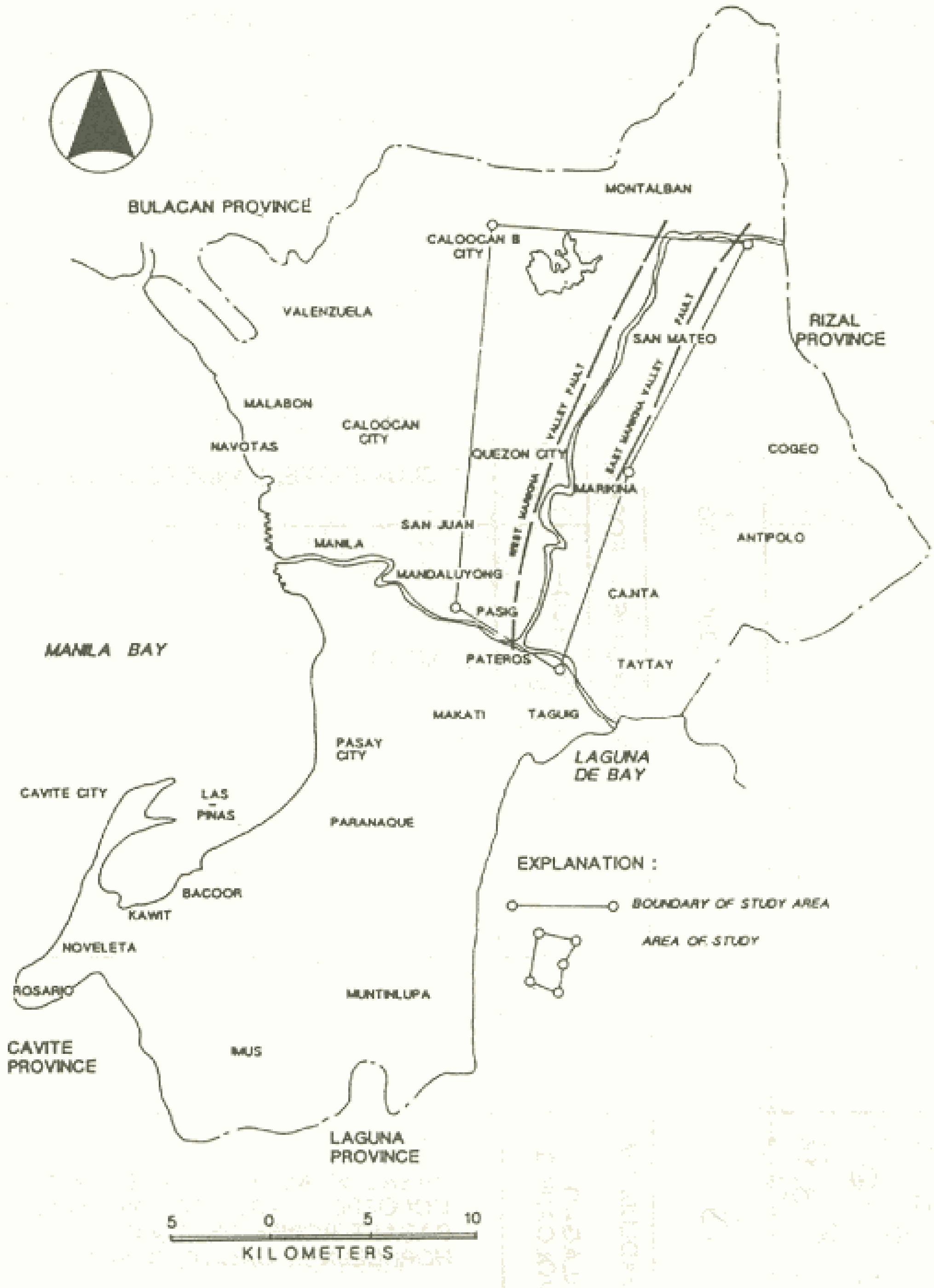

FIG. 1 : LOCATION OF STUDY AREA.

AGE		COLUMN	THICKNESS (m)	NAME		DESCRIPTION
QUATERNARY						ALLUVIAL AND MARINE DEPOSITS UNCONSOLIDATED GRAVEL, SILT & CLAY
PLEISTOCENE			1,300 – 2,000	GUADALUPE FORMATION	DILIMAN TUFF	PYROCLASTICS – ANDESITIC AGGLOMERATE, LAPILLI TUFF, TUFF SEDIMENTARY – TUFFACEOUS CONGLOMERATE, SANDSTONE, SILTSTONE
					ALAT CONGLOMERATE	NO EXISTING DATA IN STUDY AREA
PLIOCENE						
MIOCENE	LATE					
	MIDDLE		?	MADLUM FM.	ALAGAO VOLCANICS	BASALTIC AGGLOMERATE-VARICOLORED CLASTS OF PYROXENE BASALT PORPHYRY, TUFF HORNBLENDE DACITE, CHERT

Figure 2. Local stratigraphic column of the study area.

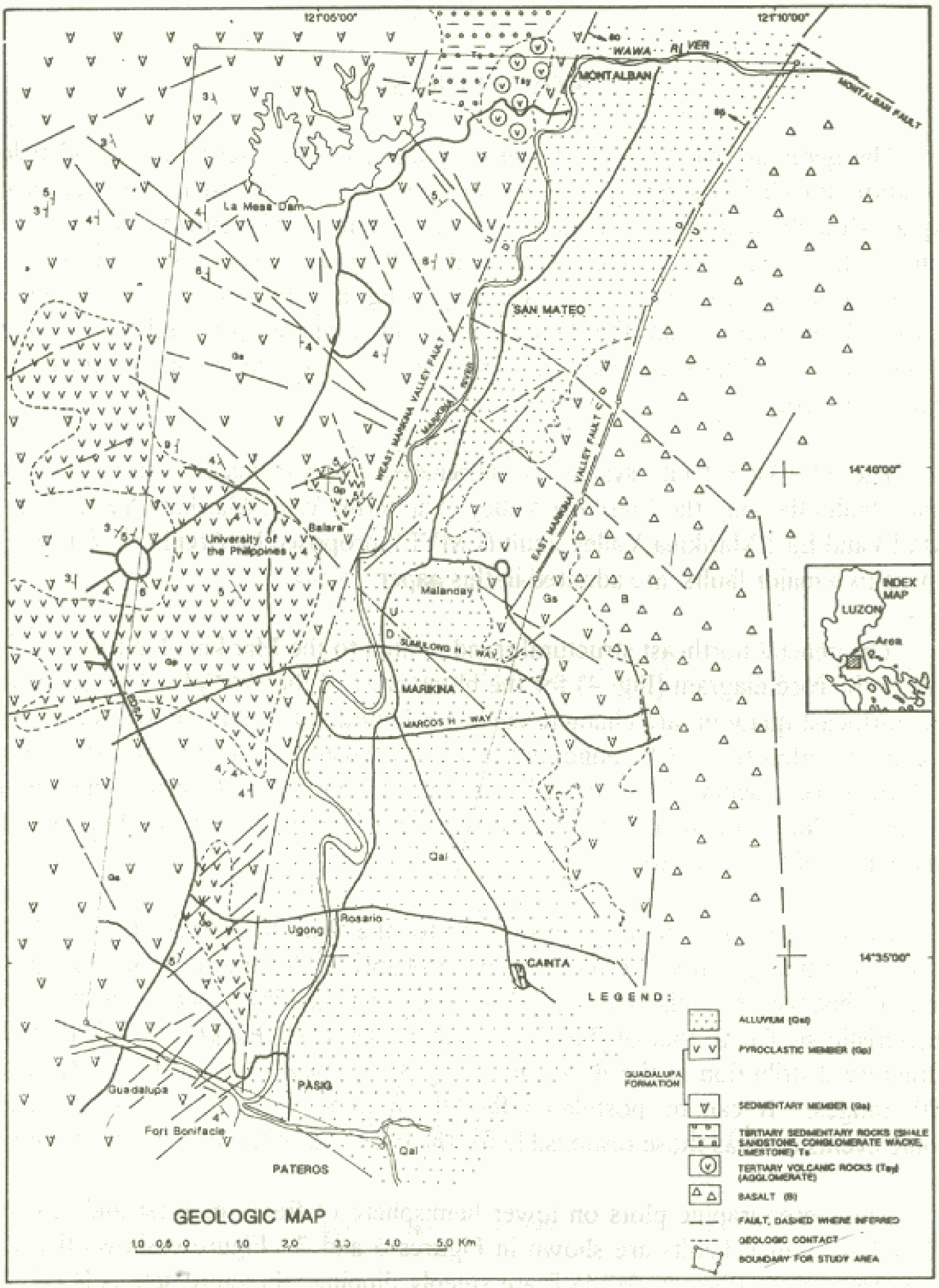

Figure 3. Geologic map of the study area.

STRUCTURES

The geologic map (Fig. 1) based on photogeologic interpretation and field observation for this study reveals four fault systems in the area: the Marikina, Nangka, Montalban and the Guadalupe Fault systems. Movements along these structures strongly influenced the morphology of the study area. Several secondary faults or fracture systems can be observed traversing the fault zone and its vicinities. The rock formation within the fault zones and vicinities are highly fractured generated by the Marikina Faults. The fractures are commonly unfilled by secondary materials.

The Marikina Fault system is dominated by two major north-northeast trending faults flanking the Marikina Valley. The terms West Marikina Valley Fault (WMVF) and East Marikina Valley Fault (EMVF), proposed by Arcilla *et al.* (1983) for these two major faults, are adopted in this paper.

The general northeast structural trend related to the Marikina Fault system is shown in the rose diagram (Fig. 4) for the block west of the WMVF. The fractures in the northeast quadrant are characterized by a bimodal distribution consisting of a first cluster within the 0-30° range and a second cluster within the 50-70° range. The former represents those directly related to the WMVF while the latter apparently belongs to an older fracture system which is cut by WMVF in the southern part of the study area.

In contrast, the rose diagram (Fig. 5) for the fault block east of the EMVF shows a multimodal fracture population probably reflecting a more complex structural history for this sector. The northeast quadrant shows a bimodal characteristic similar to that of the block west of the WMVF. On the other hand, the fracture distribution in the northwestern quadrant peaks within the 20-30° and 60-70° ranges. It can be postulated that these trends may be related to older tectonic events such as those responsible for the upheaval of the Cretaceous basalts.

The stereographic plots on lower hemisphere of fractures west and east of the Marikina Valley Faults are shown in Figures 6 and 7. Figure 6 shows that all sets of structures within the WMVF are steeply dipping. Fracture sets A,B,C,D,E (Fig. 6) are densely populated structures which are almost perpendicular to the WMVF. Sets A and B (Fig. 7) show that the dominant sets of structures within the fault block east of the EMVF are likewise perpendicular to the EMVF.

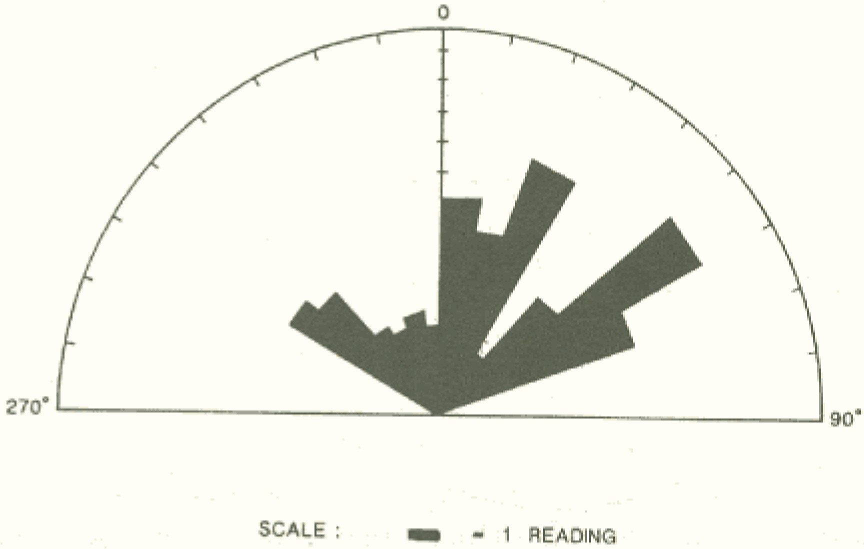

Figure 4. Rose diagram of fractures within Dilimin tuff west of West Marikina Valley Fault.

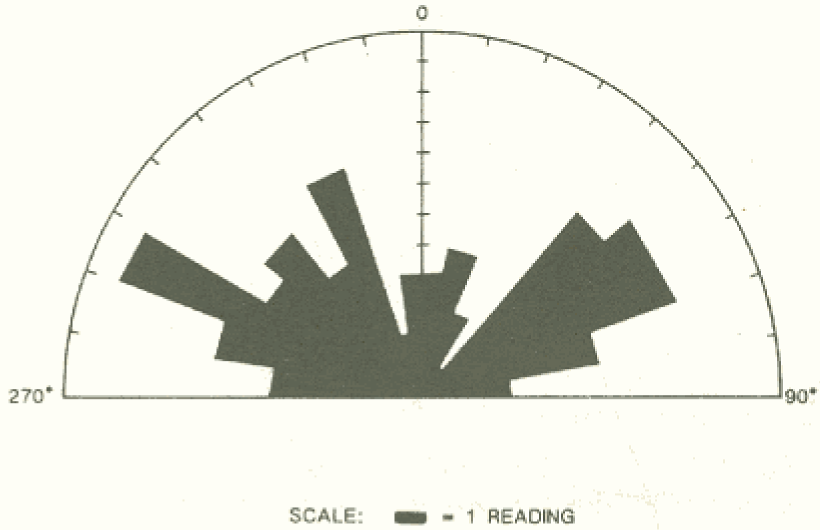

Figure 5. Rose diagram of fractures east of East Marikina Valley Fault.

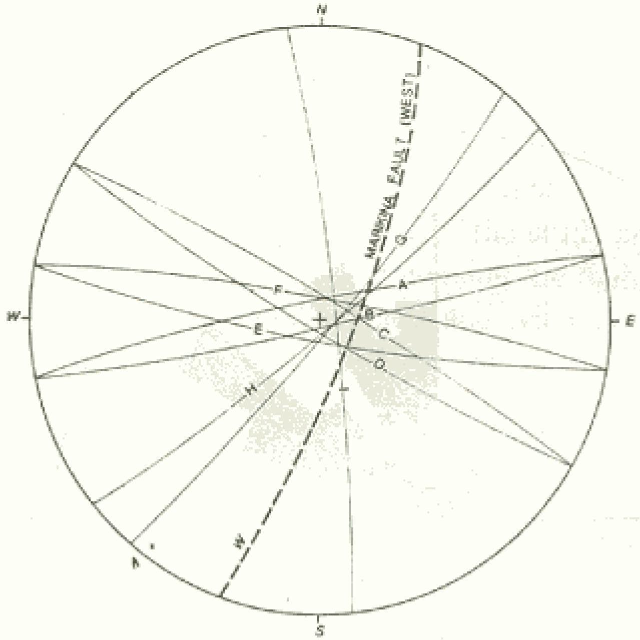

Figure 6. Stereographic plot of major structures west of East Marikina Valley Fault.

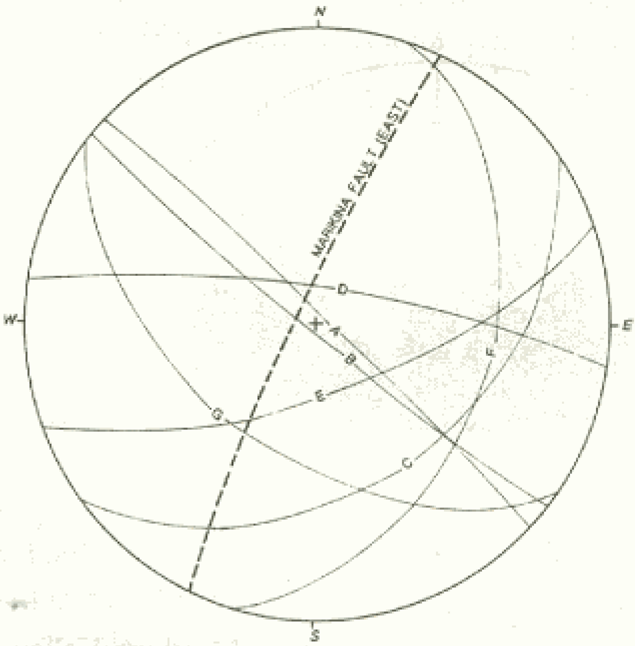

Figure 7. Stereographic plot of fractures east of East Marikina Valley Fault.

West Marikina Valley Faults (WMVF)

The WMVF is a steeply dipping continuous structure from the south (Pasig) to the north (Montalban). Its normal fault displacement is indicated by the east-facing linear scarp where the Guadalupe Formation is widely exposed in contrast to the topographic low (Marikina Valley) to the east where the alluvial deposit is thick. Outcrops in Ayala Heights Subdivision and Loyola Grand Villas show an 85m and 56m respectively vertical displacement.

East Marikina Valley Fault (EMVF)

The EMVF controls the eastern boundary of the Marikina Valley. It serves as the boundary of the basalt and the alluvium in the northern portion of the study area while it cuts the Guadalupe Formation in the central portion. The topographic break in the north indicates a minimum displacement of 400 m. This structure is discontinuous in the southern part in Marikina and the east of Pasig. This is attributed to a displacement towards the west and a subsequent burial under a thick alluvial cover.

Montalban Fault

The Montalban Fault strikes N45°W and dips steeply to the north east Oca and Potenciano (1968). It has a right strike-slip component as indicated by the displacement of the limestone ridges along the gorge in Montalban River at Barrior Wawa. Recent investigations are consistent with the observations of Oca and Potenciano (1968) that the northwest trace of the Montalban Fault is lost as it intersects the EMVF north of Montalban. This relationship suggests that the Montalban Fault is comparatively older than the Marikina Valley Fault system.

Nangka Fault System

The Nangka Faults are located in the central portion of Marikina Valley (San Mateo-Marikina block). These are northwest-trending structures controlling the Nangka River and its vicinities. They are probably of strike-slip origin as indicated by the displacement of the river courses.

As this area is bounded by the north west lineaments of the Nangka Fault System, it is postulated that the Marikina-San Mateo is an uplifted block (Fig. 1).

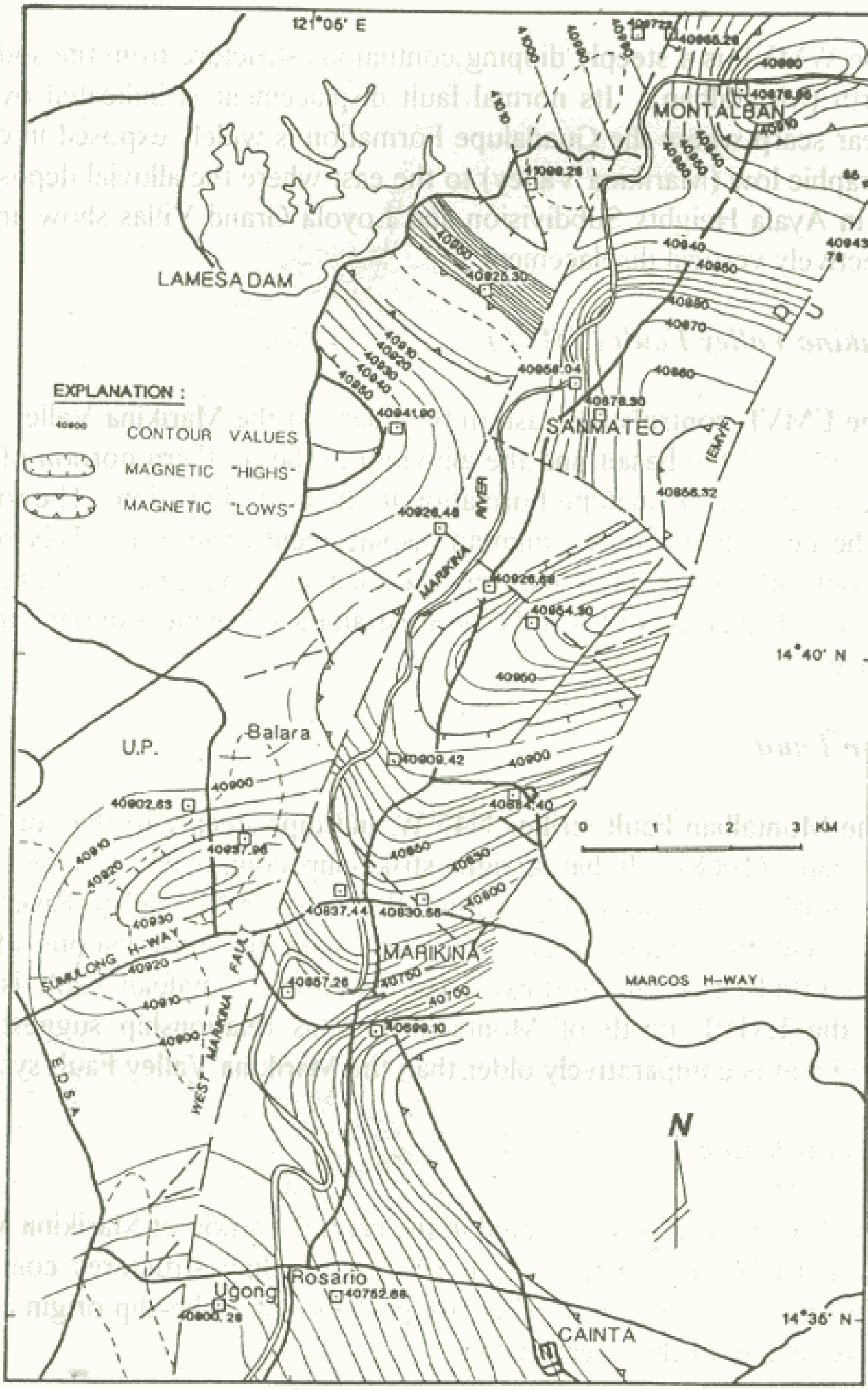

Figure 8. Total magnetic intensity map of the study area.

The high density of lineaments in the central block is believed to be hosted by the Guadalupe Formation and not by the Quaternary Alluvium and may represent faults related to the uplift of this block.

These interpretations are further supported by geological and geophysical data particularly pertaining to magnetism and gravity (Bachman *et al.* 1983).

The geophysical interpretations are supported by the high magnetic and gravity zone anomalies in the uplifted central block in contrast with the low magnetic and low gravity values in the bounding blocks in the north and south (Figs. 8 and 9).

Previous work (Gervasio 1968) stated that the alluvium is thin within the Marikina-San Mateo area. Current review of borehole data confirms the existence of a thin layer of alluvium in the central portion of the Marikina Valley, i.e., Marikina-San Mateo, in contrast to its thick occurrence in the Pasig-Marikina area in the south and the San Mateo-Montalban area in the north. Moreover, field mapping shows that the Guadalupe Formation is exposed along the bed of the Marikina River.

Fault Systems in the Western Block of WMVF

These faults are mainly located within the Guadalupe Formation in the Western Fault block of the WMVF. These are generally northeast and northwest trending structures.

The first group is concentrated in North Balara and in the vicinity of La Mesa Dam. These structures are believed to be part of the Nangka Fault System but lost their continuity to the west as they were cut by the WMVF. The second group, located in the south western portion of the Fault block west of the WMVF, appears to control the course of the Pasig River.

Fault Systems in the Eastern Block of EMVF

The faults are mainly located within the Cretaceous Basalt Formation in the eastern block of the EMVF. Several faults were inferred from aerial photographs and landsat imagery (Fig. 1 and Fig. 10).

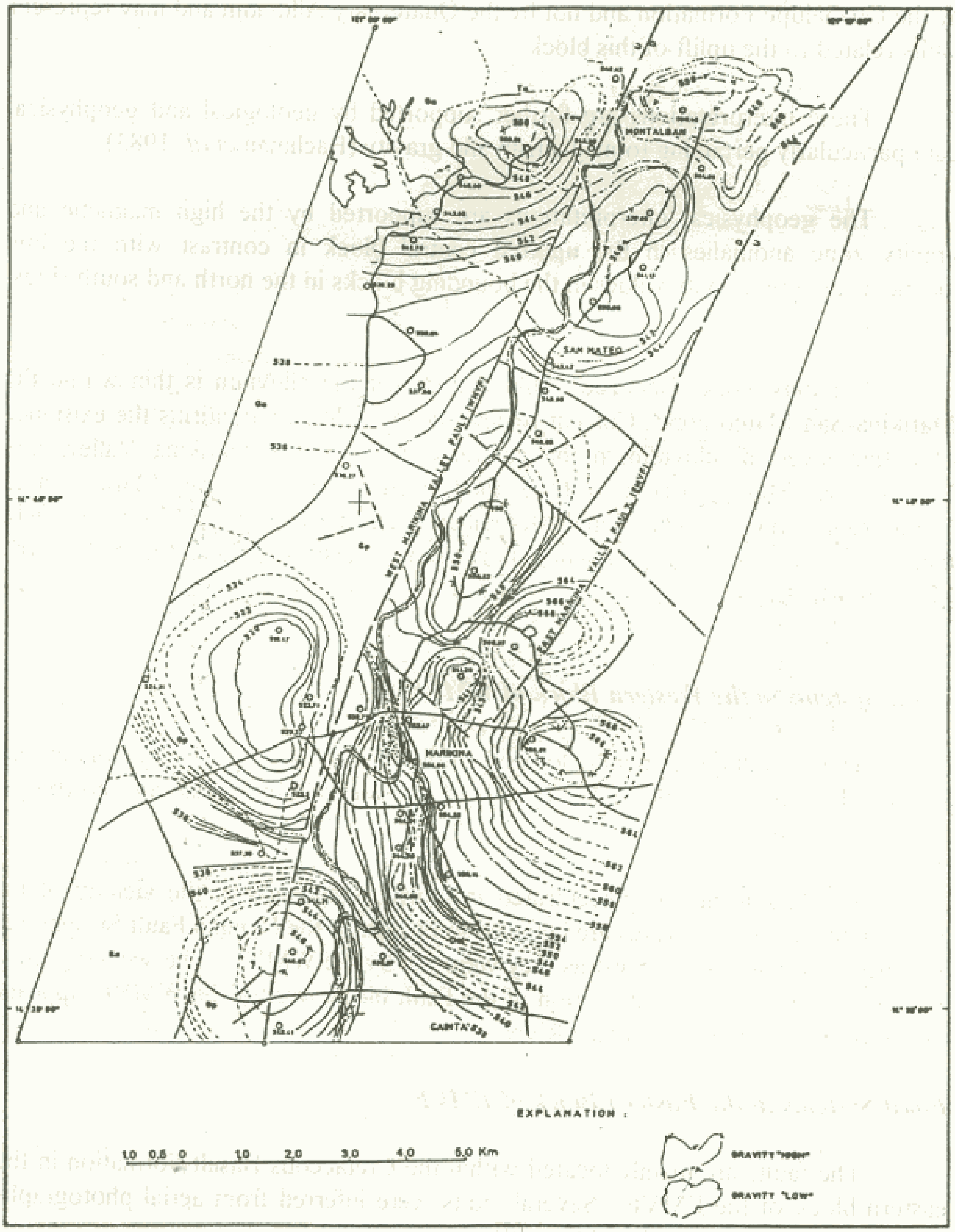

Figure 9. Gravity anomaly map of the study area.

DISCUSSION

A series of tectonic events, mostly predating the Pleistocene deposition of the Guadalupe Formation, account for the structural evolution of the basin. One of these, a Late Miocene to Early Pliocene compressive event, probably gave rise to two coeval but possibly independent fault systems (Schoell, personal communication), northeast-trending Montalban and Nangka Fault Systems. This crustal unrest is probably related to the onset of movement along the Philippine Fault (Tamesis *et al.* 1982; Karig 1983, in Arcilla 1983).

During the Pliocene, the southern part of the basin including the Marikina area, was still submerged. The sea level underwent a series of oscillations, and portions of Paranaque experienced exposure and resubmergence events (Gervasio1968). This phase in the geologic history could have facilitated the trapping of marine water, now called connate water.

Terrestrial conditions prevailed during the Pleistocene and gave way to the deposition of the Guadalupe Formation. Synsedimentary volcanism resulted in the intimate interbedding and interfingering of epiclastic and pyroclastic materials representing various facies such as airfall and fluviatile deposits. Paleosol horizons developed during brief exposures of the sediments to the agents of weathering.

Tectonic activities along the Marikina Faults took place after the deposition of the Guadalupe Formation resulting in a number of fault blocks. This event is recorded in the fractured rocks and extensive development of gouge within the faulted portions of the Guadalupe Formation. The EMVF could have had a relatively earlier movement than its western counterpart to account for the exposure of the Cretaceous basalt in the eastern fault block.

Present stream morphology also provides some clues on the paleogeography of the area. Gervasio (1968) observed that in the Quezon City area, most of the streams were already at a mature stage when movements along the Marikina Fault lines occurred. On the other hand, the Marikina River could have taken advantage of the weak line along the WMVF and subsequently followed the fault trend. Furthermore, the Pasig River cut through the Marikina Fault scarp in relatively recent times and captured the Marikina drainage system and Laguna de Bay.

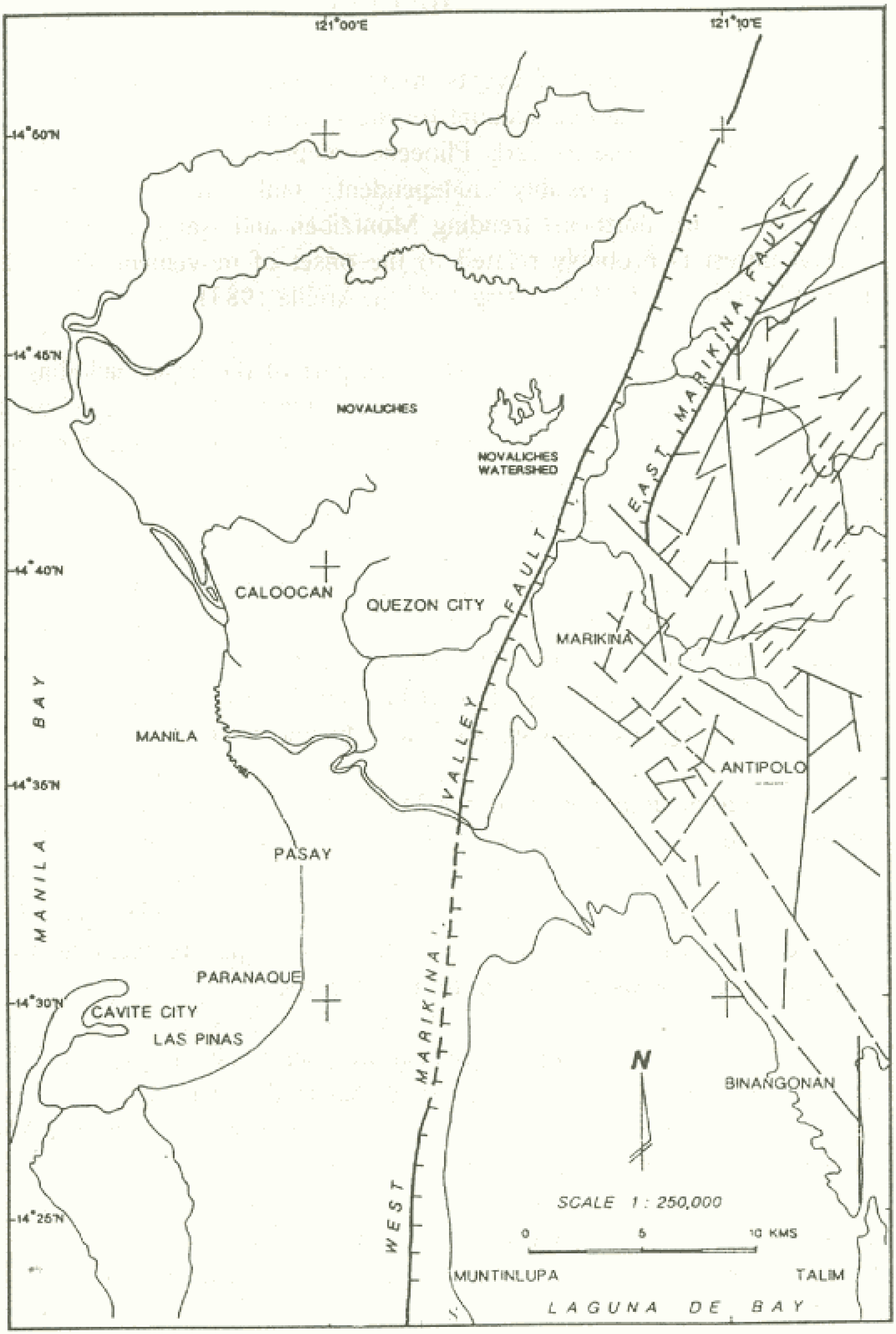

Figure 10. Stuctural map delineated from Landsat Imagery.

Such tectonic setting, coupled with the various sedimentary facies, has made correlation studies a complicated task. Tracing of stratigraphic continuities is aggravated by the interfingering relationships of permeable and impermeable strata.

The overall spatial distribution of the structures in the study area shows that the Marikina Fault System cuts the Nangka Fault System while the trace of Montalban Fault disappears as it intersects the EMVF.

Oca and Potenciano (1968) reported that there are seismological evidences which indicate that the epicenter of the earthquake of 1836 emanated from the Marikina Valley Faults although no details of these evidences were mentioned. This is significant in terms of the Marikina Faults in recent times.

The high gravity anomalies indicate the presence of Guadalupe Formation at shallow depths in the San Mateo-Marikina block while the high magnetic anomalies point to the presence of highly oxidized paleosol horizons which are often present within the Guadalupe Formation in the GMA. The present study attributes this to the raising of the bed rock in Marikina-San Mateo area.

CONCLUSIONS

In the light of the available information obtained from this study, the following conclusions are drawn:

a) Three lithological units are present in local mapping area, namely; the Alagao volcanics, Guadalupe Formation and Quaternary alluvium.

b) Movement along Marikina Fault gave rise to the development of an east facing escarpment and relatively flat valley in down thrown block.

c) The overall distribution of the structures in the study area shows that the Marikina Fault System cuts the Nangka Fault System while the trace of Montalban fault disappears as it intersects the east Marikina Valley Fault (EMVF).

d) The west Marikina Valley Fault is the youngest fault in the study area.

e) An uplift occurred at the central portion of the Marikina Valley (San Mateo-Marikina block).

REFERENCES

Arcilla C.1983. A model for Quadrangle Mapping in the Philippines.

Bachman S.B., S.D. Lewis and W.L. Schweller 1983. Evolution of a Forearc Basin, Luzon Central Valley, Philippines. *American Association of Petroleum Geologists Bulletin*, 67(67): 1143-1162.

Gervasio' F.C. 1968. The geology. Structures and Landscape Development of Manila and suburbs. *Philippine Geologists*, 22(4): 178-192.

Oca G.R. and J.F. Potenciano 1968. Geology and foundation problems of the projected Marikina Arch Dam. *Philippine Geologists*, XVIII: 119-226.