

CATATAN GEOLOGI

Geological Notes

Gravity base stations in Sabah, East Malaysia

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INTRODUCTION

Because gravity meters measure only gravity differences, and not absolute gravity values, base stations are needed through which local surveys can be linked to the international absolute network (currently denoted by the acronym IGSN71). The locations and gravity values of all base stations need to be publicised, and clear descriptions must be available. This note describes base stations established in Sabah in 1995 as part of a programme of co-operation between the Geological Survey of Malaysia and the University of London.

PREVIOUS BASE STATIONS IN EAST MALAYSIA

Ironically, East Malaysia in the early post-war years was more securely linked to the international gravity network than was West Malaysia, largely because the role of Singapore airport as the regional airline 'hub' led to a concentration of stations on what is now the Republic of Singapore. International base stations on the Potsdam system in Sabah and Sarawak were listed by Woollard and Rose (1963) as in (Table 1).

These were presumably the base stations

Table 1. International base stations in Sabah and Sarawak (Woollard and Rose, 1963).

Kuching	WA2065	1	29.0	110	20.5	24.5	978076.3
<i>Air terminal, immediately inside folding door to "Immigration" waiting room, 3' above tarmac level</i>							
Sibu	WA2066	2	18.0	111	49.9	6.0	978079
<i>Control tower building outside door to building near step to tower on building apron.</i>							
Jesselton	WA2054	5	57.0	116	03.5	2.0	978127.9
<i>Airport. Inside meteorological enclosure on field side of terminal on north train-catcher base, 1" above ground level.</i>							
Labuan	WA2055	5	18.2	115	15.2	29.9	978096
<i>Airport. To right of steps leading to customs and immigration from field, 6" below field level.</i>							
Sandakan	WA2056	5	54.1	118	04.0	11.6	978091.4
<i>Air terminal, at base of wash bowl in "Gentlemen's" lavatory.</i>							

used when, in 1964, the US Army Map Service (Far East) established a regional gravity network of some 300 new stations in northern and western Sabah. The link to the then current international system was strengthened in 1966 when the West Pacific Calibration Line (WPCL) linked Fairbanks in Alaska to Hobart in Tasmania via Vladivostok, Tokyo and Canberra. In Malaysia, WPCL stations were established at the University of Malaya in Kuala Lumpur (WPCL value 978 048.96 mGal) and in Kuching. Additional loops in 1970 and 1971 produced an adjusted value of 978 075.32 mGal for Kuching and a new value of 978 095.02 mGal for Labuan. The absolute gravity values listed in most international data bases for the USAMS(FE) survey are thought to have been referenced to this value for the Kuching base. The University of Malaya base was subsequently incorporated into the current IGSN71 network with a value of 978 034.41 mGal. This is 14.55 mGal less than the WPCL value and implies the need for a similar adjustment to the linked stations in East Malaysia. The shift is slightly greater than the 14 mGal correction usually applied to convert Potsdam to IGSN71 values and was therefore presumably obtained as a result of additional measurements.

A serious drawback to the WPCL was that virtually all stations were at international airports, often 'airside' of Customs and Immigration. Increased security precautions introduced since 1966 have made access to such stations difficult, and it is also rare to find airports which have changed so little that the WPCL stations can still be identified. These problems are common to virtually all airport stations, including Woollard and Rose WA2054 at the original Kota Kinabalu (then Jesselton) airport. StJohn (1981) re-occupied this latter station (at what is now known as 'Lapangan Terbang Lama') and backed it up with a 'landside' excentre a short distance away, with the recommendation (unfortunately apparently ignored) that additional excentres be established in more secure locations. When the airport was visited in 1995, StJohn's excentre was found to lie within a partially excavated building site. Although the original airside station could not be precisely located, an approximate tie was made by reading the gravity meter at a

point some ten metres away and at what must have been a very similar elevation. Comparison with the value obtained in 1995, based on the new link between Kota Kinabalu and the University of Malaya base in Kuala Lumpur suggested that the adjustment to the USAMS(FE) values should be 13.7 mGal, rather than 14.55 mGal. The average discrepancy between 1995 and USAMS(FE) gravity stations in approximately the same locations was also found to be close to 13.7 mGal, and this value has therefore been used in integrating the older data with the 1995 results.

THE MALAYSIA NATIONAL GRAVITY BASE

The Malaysian National Gravity Base is in the Makmal Fizik (Physics Building) of the Universiti Malaya in the suburbs of Kuala Lumpur. The building is situated behind and to the left of the main Fakulti Sains block and opposite the building housing the Geology Department. A printed station description sheet is available but the sketch map no longer corresponds very closely to the situation on the ground. Modifications to the laboratories have resulted in a new doorway being opened up immediately next to the station site, and the concrete benches and darkroom mentioned in the original description have been removed. A sign by the new door indicates that this area is now the 'Makmal Plasma'. There were in 1995 still staff in the Physics Department who could guide visitors to the gravity station, but this situation may not last much longer. Moreover, further modifications could destroy the site, thus removing the only direct Malaysian link to the IGSN71 network. It is therefore desirable that an excentre be established by repeated ties to the existing base and that new description sheets be prepared for both stations. The nearby Geology Department would seem an ideal location for the excentre.

The precise reading point in the Makmal Plasma is indicated by a brass plaque on the floor, inscribed:

GRAVITY STATION UNIVERSITY OF MALAYA PHYSICS LAB
REF JPNM G4/76

whereas on the data sheet the station is designated 'Kuala Lumpur 02631 B IGSN 71'.

This discrepancy, taken together with the differences between the station description and the site marked by the brass plaque, raise some doubts as to whether the two sites actually are the same. These doubts are reinforced by the discrepancy between the expected IGSN71 value, based on the standard Potsdam/IGSN71 conversion factor of 14.0 mGal, and the 14.55 mGal value quoted by StJohn (1981). It is clearly desirable that the Kuala Lumpur base be linked much more securely to the international system.

1995 SABAH GRAVITY TIES

The 1995 regional gravity survey employed the low drift LaCoste-Romberg geodetic gravity meter G90, owned by Imperial College, London. This meter was read at the University of Malaya base on 5 July and again, following completion of the survey work in Sabah, on 7 August. Total drift during this period of 33 days was less than 2 mGal and was monitored at a base in the Sungei Wang Hotel in central Kuala Lumpur and a number of bases in Sabah..

The most important of the Sabah bases is the station at the Geological Survey building in Kota Kinabalu, and it is recommended that this be adopted as the primary gravity base for Sabah. Other described and reoccupiable bases were established in Telupid, Lahad Datu, the Danum Valley Field Centre, Tawau, Luasong and Tambunan (Figs. 2a and 2b). The currently accepted Principal facts for these bases are listed in Table 2. The network (Fig. 1) was created using a system of forward looping. Thus, a new station was established at Telupid en route from Kota Kinabalu to Lahad Datu, where a second new station served as a base for a number of days. Side loops from Lahad Datu allowed bases to be established at the Danum Valley Field Centre. From Lahad Datu a loop included a temporary site at the Semporna-Tawau road junction which was reoccupied from Tawau after the base had been moved there. A loop from Tawau then reached to the forestry base at Luasong, which was in turn used as a base for three loops, one of which included a temporary site at the forestry centre at Tongood. From Tongood the survey was tied back to Telupid and thence to Kota Kinabalu. An

additional loop from Kota Kinabalu allowed a base to be established at Tambunan.

The weakest section of the network is the direct link from Telupid to Lahad Datu, since this road was used once only, in one direction only, with closure back to Telupid 17 days later. The link between the western and eastern sides of Sabah was therefore reinforced by a direct tie between Lahad Datu and Kota Kinabalu using the scheduled air service. Although the main loop extended over a period of 19 days, the absence of tares, the use of multiple repeat readings throughout the survey and the existence of the air tie has allowed gravity values relative to Kota Kinabalu to be estimated at all loop bases with estimated uncertainties of no more than 0.04 mGal. This estimate is believed to be valid even though completion of the main loop had to be delayed for 16 hours because the first attempt at reoccupation in Kota Kinabalu, at 1423 on 31 July, was affected by long period ground vibrations associated with the Antofagasta earthquake which occurred about a quarter of an hour earlier. Since various phases and modes of this shock wave were expected to arrive over a considerable period, the loop was not finally closed until early the following day.

In 1996, during the Geological Society of Malaysia annual meeting in Kota Kinabalu, the base at the Geological Survey Office was tied to the current Kuching base by U.W.A. Sirisena, using a LaCoste-Romberg model G gravity meter belonging to the Geological Survey of Malaysia.

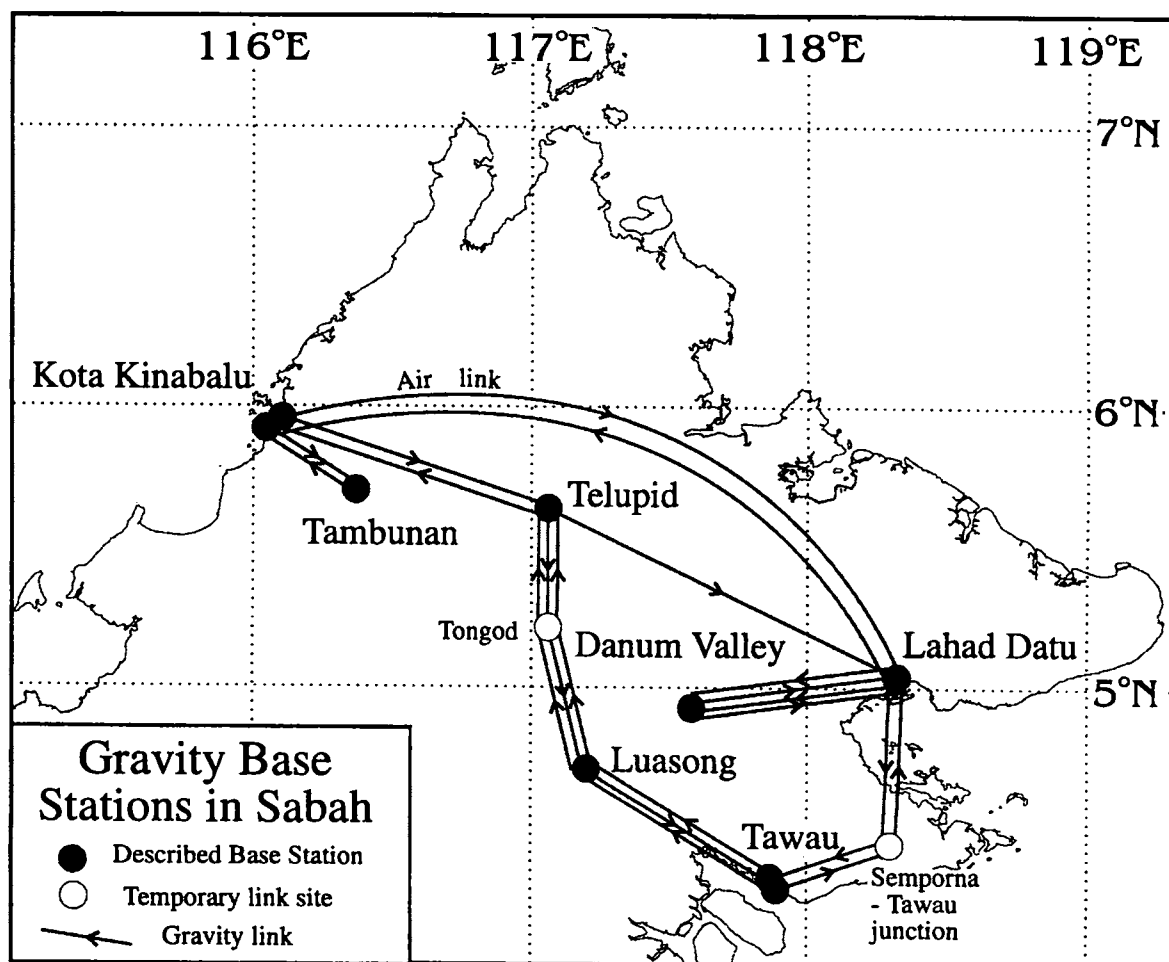
RECOMMENDATIONS

A start has been made on developing a gravity base network for Sabah. However, the network does not yet reach international standards, because of the small numbers of links supporting the network, and also because of uncertainties associated with the Malaysian National Base in Kuala Lumpur. The following recommendations are therefore made.

1. An inscribed brass marker plaque should be positioned on the site of the main Sabah base in the Geological Survey offices in Kota Kinabalu.

Table 2. Principal facts for Sabah gravity bases.

Station No.	Location	Latitude	Longitude	Height (m)	Observed g
9502.9002	Kota Kinabalu	5°07.53	116°04.43	3.4	978112.19
9502.9028	Telupid	5°37.68	117°07.86	100.7	978151.66
9502.9029	Lahad Datu	5°01.58	118°20.01	6.1	978156.53
9502.9059	Danum Valley	4°57.83	117°48.17	154.5	978064.12
9502.9060	Danum Valley	4°57.83	117°48.16	162.9	978062.75
9502.9169	Tawau	4°14.80	117°52.93	1.9	978112.93
9502.9170	Tawau	4°15.72	117°53.04	14.3	978110.89
9502.9185	Luasong	4°36.60	117°23.71	134.1	978042.45
9502.9243	Luasong	4°36.60	117°23.68	134.1	978042.48
9502.9301	Tambunan	5°40.17	116°21.93	575.3	977939.97

**Figure 1.** Gravity base stations in Sabah.

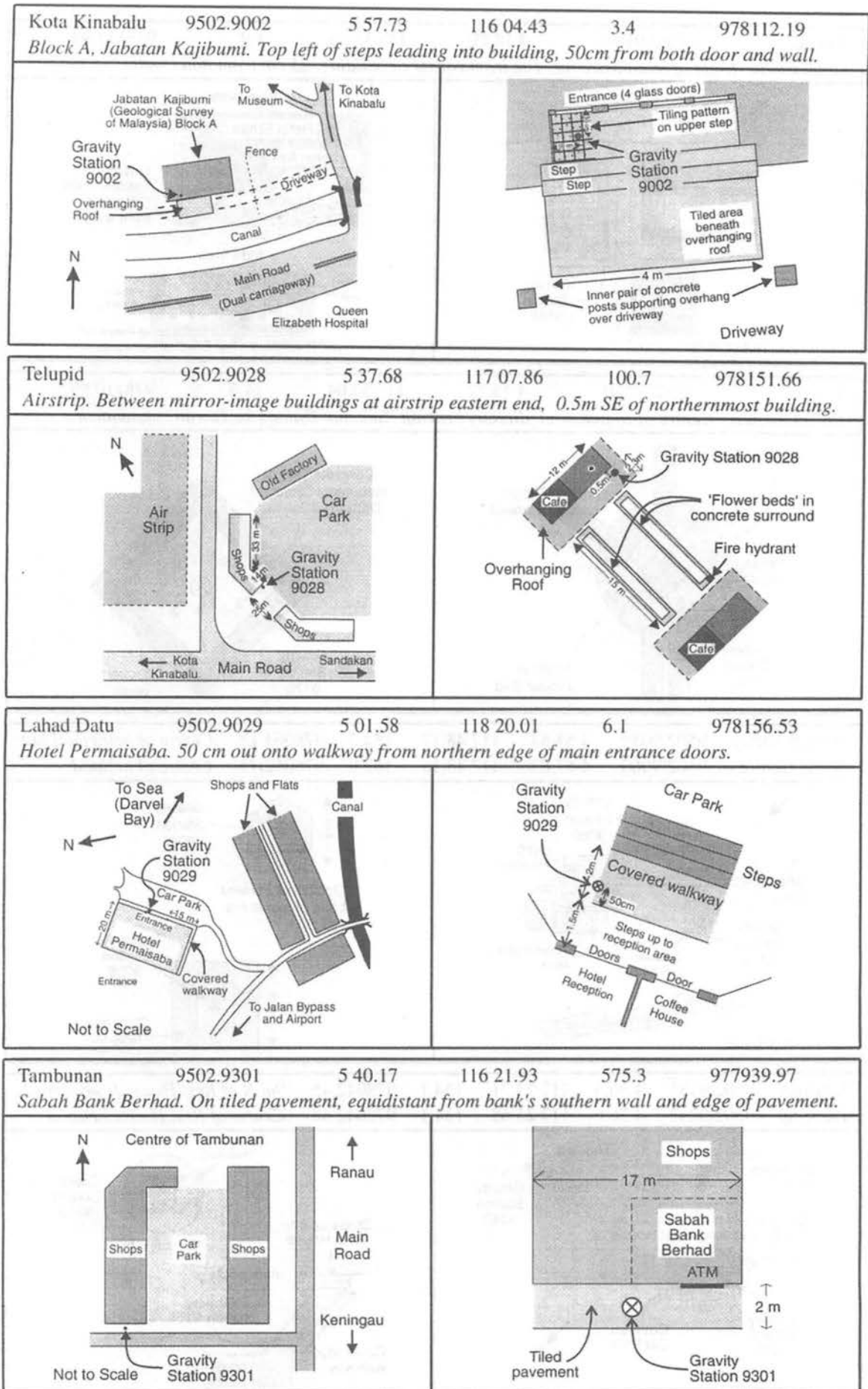


Figure 2a. Locations of the gravity base stations.

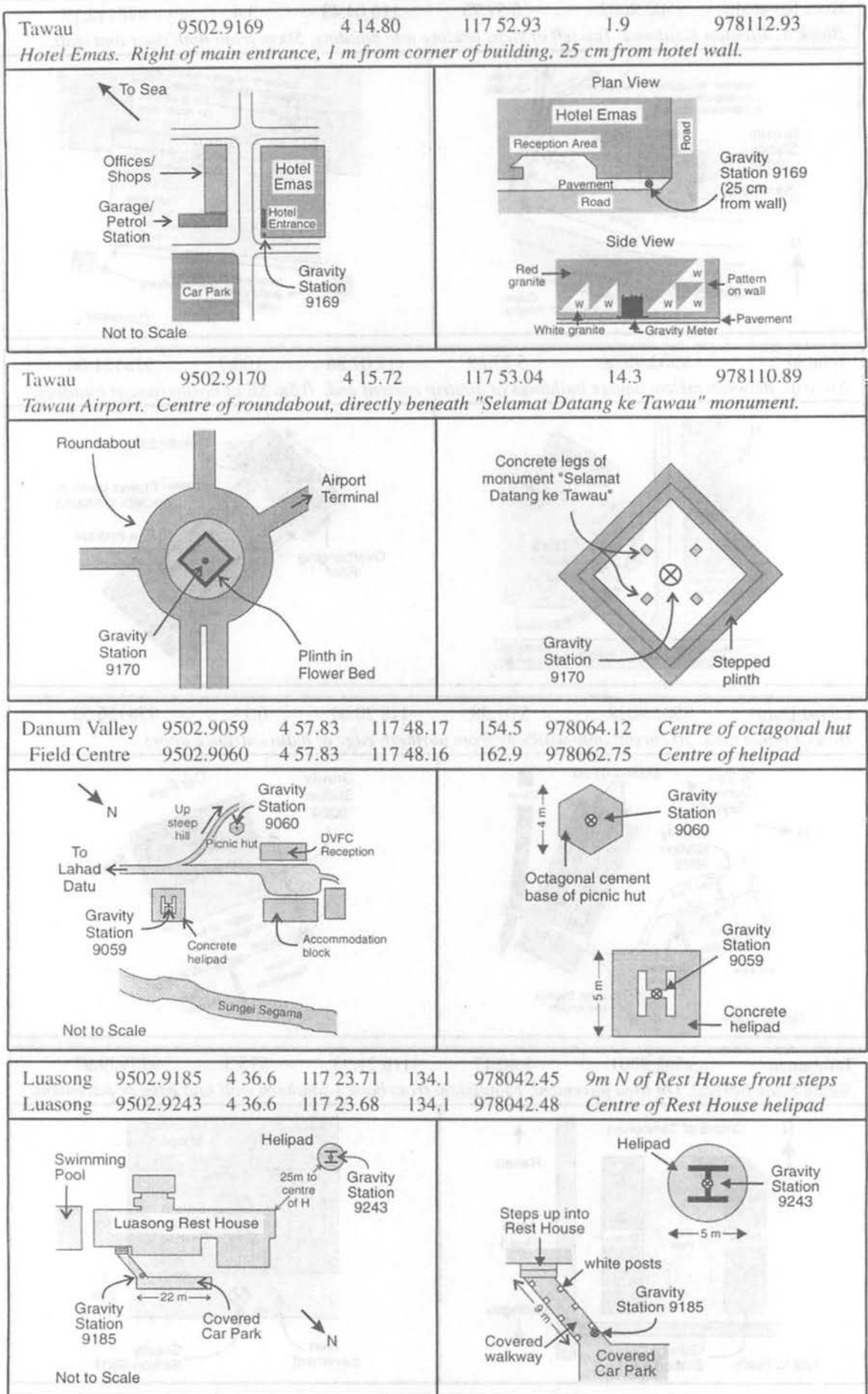


Figure 2b. Locations of the gravity base stations.

2. This station, and the other stations described in this report, should in future be used as the base stations for all gravity work in Sabah.
3. Advantage should be taken of every opportunity provided by gravity meters in transit to strengthen the gravity ties between East and West Malaysia, and between sites in East Malaysia.
4. Advantage should be taken of any opportunities that arise to link bases in Malaysia to bases in Singapore and adjacent parts of Indonesia.
5. The history of the University of Malaya base station in Kuala Lumpur should be investigated and a new station description sheet should be prepared.
6. A new gravity excentre should be established in the Geology Department at the university.

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- WOOLLARD, G.P. AND ROSE, J.C., 1963. International Gravity Measurements. *Soc. Explor. Geophys Spec. Publ.*, Tulsa, Oklahoma.

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