

Chapter 1

Introduction

Location and Physiography

This report is the third in a series of geological reports and associated 1:5 000-scale geological map sheets covering the development areas of Lantau Island. It describes the geology of northern central Lantau Island, with special reference to complex ground conditions at Tung Chung New Town, and offshore areas along the North Lantau coast earmarked for reclamation and future infrastructure development. The report should be read in conjunction with two revised 1:5 000-scale map sheets 9-SE-A and 9-SE-B (revised 2002), and parts of three 1:5 000-scale geological map sheets previously described within the scope of Sheet Report No. 4 (Geology of North Lantau Island and Ma Wan). The study area also covers offshore parts of 1:5 000-scale map sheet 9-NE-D, previously described by Sheet Report No. 2 (Geology of Chek Lap Kok), and part of 1:5 000-scale map sheet 10-NW-A, which remains unpublished. The main purpose for including offshore areas within the scope of this study is to incorporate the improved understanding of the offshore solid and superficial geology, which has resulted from new geophysical and borehole evidence. Much background detail is also contained in Hong Kong Geological Survey Map Sheets 9 (Tung Chung) and 10 (Silver Mine Bay), and Memoir No. 6 (Geology of Lantau District). Woods (1993) also provides useful information on the engineering geological characteristics of rocks within the study area.

The area covered by this report is approximately 4 194 ha (Figure 1). In this report, the mapped area, along with the offshore study area stretching from Chek Lap Kok in the southwest through to Tsing Chau Tsai in the northeast, is referred to as ‘the district’.

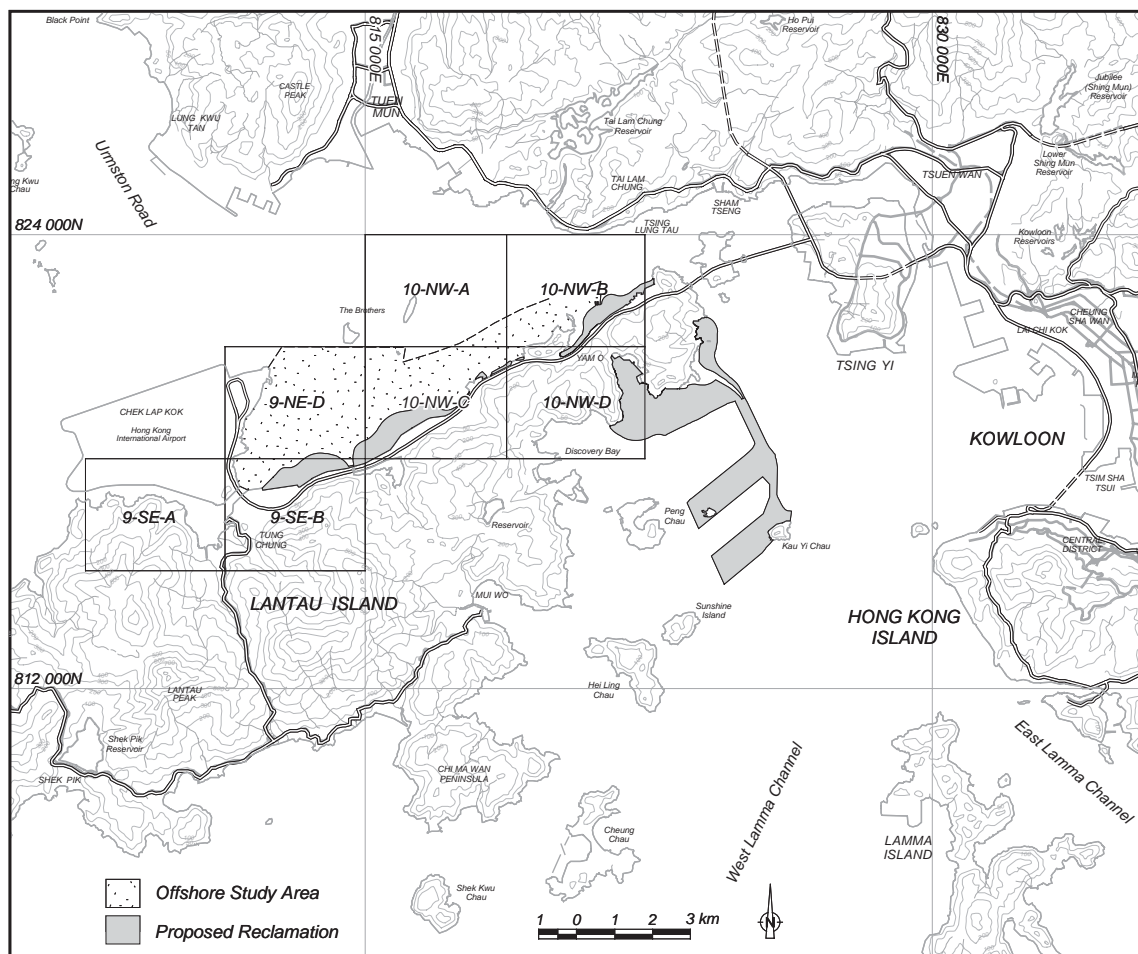


Figure 1 - Location Map of Major Infrastructure Developments Related to Tung Chung New Town and Northshore Lantau Island

The onshore part of the district occupies a region of rugged topography dominated by a central range of hills forming the backbone of Lantau Island. The highest peak in the district is Pok To Yan (529 m, 1360 1591) in the southeast. The Tung Chung valley is the dominant valley system, draining towards Tung Chung Wan in the north. In the east, a major northwest-trending valley forms Wong Lung Hang. Embayments along the North Lantau coast in the west of the district are occupied by the village settlements of Sha Lo Wan and Tin Sam.

Much of the district was formerly agricultural with subsistence farming and fishing being the dominant occupation. These areas are now largely abandoned and major tracts of land are now included within the Lantau Country Park. The low-lying area at Tung Chung, formerly a fishing village, is now being redeveloped, with high rise and other buildings and new roads being planned or under construction as part of the expansion of Tung Chung New Town.

Previous Work

The first geological investigations in Hong Kong were undertaken by Brock, Uglow, Schofield & Williams between 1923 and 1927 under an agreement between the Colonial Office and the University of British Columbia. A geological map of Hong Kong was published at a scale of 1:84 480 by Brock *et al.* (1936), and several papers relating to this work were published by Brock & Schofield (1926), Uglow (1926), Williams (1943) and Williams *et al.* (1945). The first memoir, based largely on this work, was produced by Davis (1952), followed later by a detailed description of the geology of Hong Kong by Ruxton (1960).

Allen & Stephens (1971) published the first comprehensive geological map at a 1:50 000 scale together with a descriptive report. This survey remained the definitive work on the geology of Hong Kong until 1982 when the Hong Kong Geological Survey commenced the 1:20 000-scale mapping programme (Figure 2). Bennett (1984a; 1984b; 1984c) reviewed the stratigraphy and tectonics of Hong Kong, and 1:20 000-scale geological maps covering the central Lantau Island district were published by GEO (1994) (Sheet 9) and GEO (1991) (Sheet 10). The geological memoir covering this map sheet was published by Langford *et al.* (1995). The terrain characteristics, superficial deposits and engineering geology aspects were described in the Geotechnical Areas Studies Programme Report No. IV, North West New Territories (GCO, 1988). Two new memoirs on the geology of Hong Kong, synthesising much of the information gathered during the 1:20 000 and 1:5 000-scale mapping programmes, have recently been published (Fyfe *et al.*, 2000; Sewell *et al.*, 2000).

Complex Ground Conditions at Tung Chung

Complex ground conditions at Tung Chung were first encountered during preliminary ground investigations for the Tung Chung reclamation in 1991. These conditions, including pockets of marble with cavities and deeply-weathered fault zones, have subsequently posed local problems for the design and construction of some deep foundations (e.g. under high-rise buildings). In 1996, the construction of one proposed residential tower block had to be abandoned due to adverse ground conditions. This prompted a detailed geological study on the ground conditions at the Tung Chung reclamation and its adjacent area, funded by the Territory Development Department.

British Geological Survey consultants were engaged through the Geotechnical Engineering Office to undertake the geological study which culminated in production of a report (Gillespie *et al.*, 1998) entitled “Geology of Tung Chung New Town” in September, 1998. This report confirmed the existence of complex ground in various development sites and established a geological model for Tung Chung New Town. The study concluded that complex ground might be identified in other nearby development areas and recommended the use of a combination of geophysical techniques to identify discrete occurrences and regional structural interpretations.

The Northshore Lantau Development Feasibility Study

As a result of the Territorial Development Strategy Review (TDSR) announced in 1998, and the subsequent Northshore Lantau Development Feasibility Study (NLDFS), it was recommended that the theme of Northeast Lantau be reoriented from port to tourism and recreational development. In addition to several major new tourism and recreation development initiatives in the Penny's Bay and Yam O areas, the NLDFS identified potential areas for residential development at Siu Ho Wan, linking with the planned residential development of Tai Ho New Town to the west.

Almost all of the urban, and tourism and recreation developments proposed for the north coast of Lantau are



to be associated with areas of new reclamation. In the past, some of the problems encountered in such major infrastructure developments in Hong Kong have been attributed to insufficient geotechnical and geological knowledge. The NLDFS included an initiative to examine all available site investigation data to confirm offshore ground conditions. Five additional ground investigations, including boreholes and cone penetration tests (CPTs) and two geophysical surveys, were carried out to study the geological conditions and sediment quality in the area of proposed reclamation(s). An overview of the results of these investigations are reported here. They confirm the complexity of the geology in offshore areas along the North Lantau coast.

Offshore Geophysical and Marine Ground Investigations

Additional offshore geophysical and marine ground investigations, undertaken for the NLDFS and completed in 1999, have proved depressions filled with siltstone or fine alluvial sediment to a depth of -162 mPD within 500 m of the North Lantau shoreline (Scott Wilson (HK) Ltd., 2001; Kirk *et al.*, 2000). These data indicate the presence of deep zones of weathering and marble with cavities beneath areas of proposed reclamation. The geological information to hand suggests that local areas of complex ground may be encountered beneath areas of proposed and planned infrastructure development along the North Lantau coast.

Purpose and Scope of Study

The main purpose of the 1:5 000-scale mapping programme was to provide information on rock structure, texture and composition for use by engineers involved with infrastructure development. An additional aim was to supplement existing published geological data (Langford *et al.*, 1995; GEO, 1994, (Sheet 9)) with more detailed information to help interpretation of broader aspects of the geology of Hong Kong.

In addition to a description of the geology covered by 1:5 000-scale geological map sheets 9-SE-A and 9-SE-B, this report gives a detailed account of the complex ground conditions encountered at Tung Chung New Town. It also covers the solid and superficial geology of the proposed infrastructure development area at Siu Ho Wan and the offshore area immediately east of Chek Lap Kok.

Data Sources

A large volume of borehole data for North Lantau and Tung Chung exists from previous site investigations, including those for the airport project (Figure 3). This large data set was compiled as part of a computerised database.

Aerial photographs, particularly those taken in 1963, were invaluable in mapping of onshore superficial deposits. A Landsat image of the Pearl River Estuary, although at a small scale, gave an excellent overview of the district and supplied further evidence of structural trends determined from field mapping.

From a total of 216 rock samples collected, some 171 specimens were thin sectioned and 15 samples were sent to the University of Nottingham for whole rock major and trace element geochemical analysis. Two samples were collected from the district for Rb–Sr age determinations at the NERC Isotope Geosciences Laboratory, Keyworth.

The nature and distribution of offshore superficial sediments have been mapped using shallow seismic profiles, borehole logs, and CPT traces from several surveys (Figure 4). These surveys were originally carried out in preparation for the Port and Airport Development Strategy (PADS), offshore sand resource exploration and site investigations for reclamations. Copies of seismic profiles used in this project are held by the Hong Kong Geological Survey.

The 1:5 000-scale geological maps which accompany this report are based on the Hong Kong Geological Survey field surveys, now published as a map at a scale of 1:20 000. The present report has extended this work through a detailed interpretation of the sub-surface geology based mostly on recent borehole data and offshore seismic traverses, obtained since the earlier survey. Each 1:5 000-scale sheet area is represented by one geological map showing both the solid and superficial geology.

All the records from this project, including rock samples, thin sections, manuscript maps and analytical data, are held in the archives of the Hong Kong Geological Survey, Geotechnical Engineering Office, Civil Engineering Department. The powders used in geochemical analysis are also retained in the Hong Kong Geological Survey archives, and a split is kept at the British Geological Survey, Keyworth.

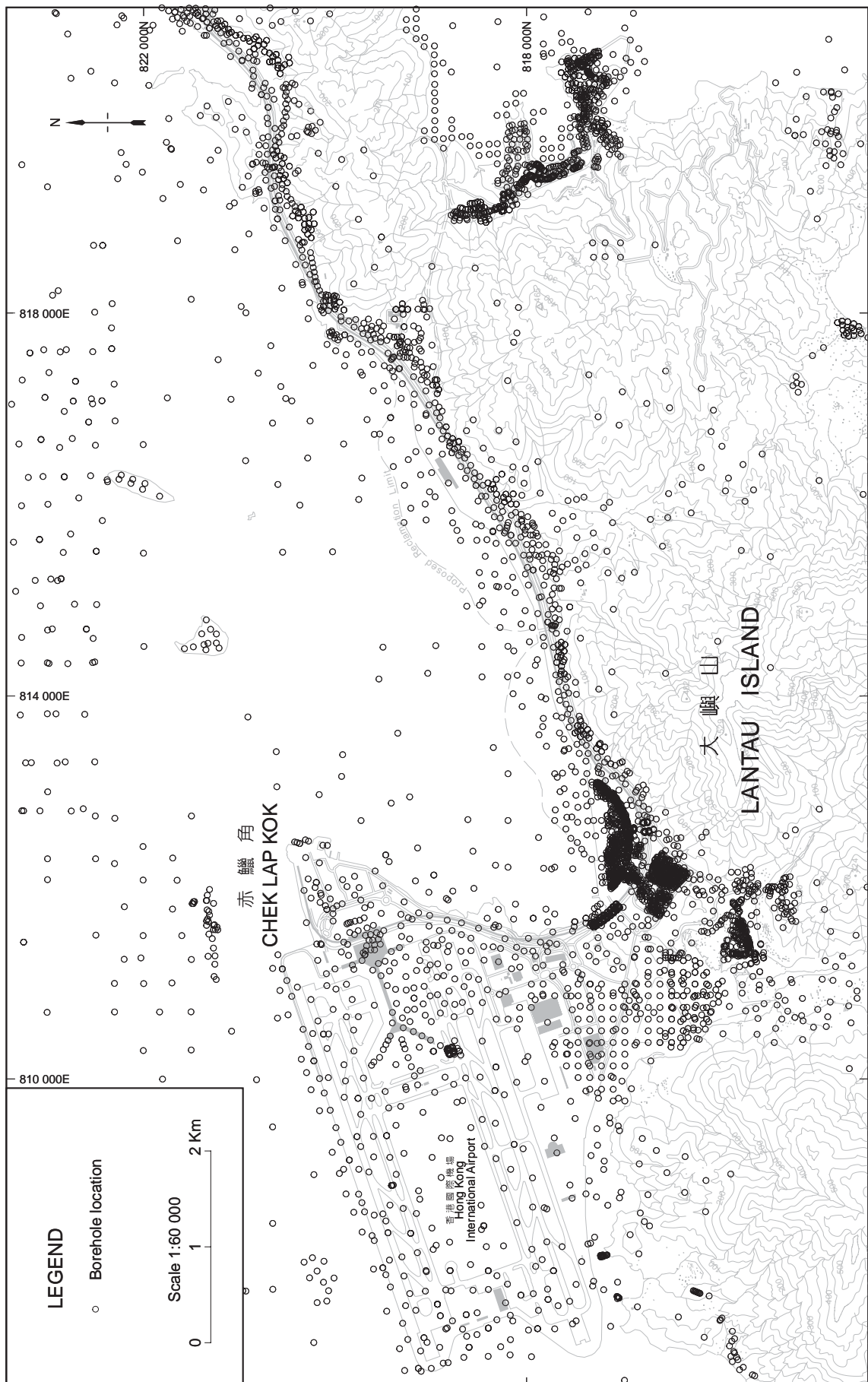


Figure 3 - Locations of Boreholes Drilled for Tung Chung New Town and Northshore Lantau Island Infrastructure Developments

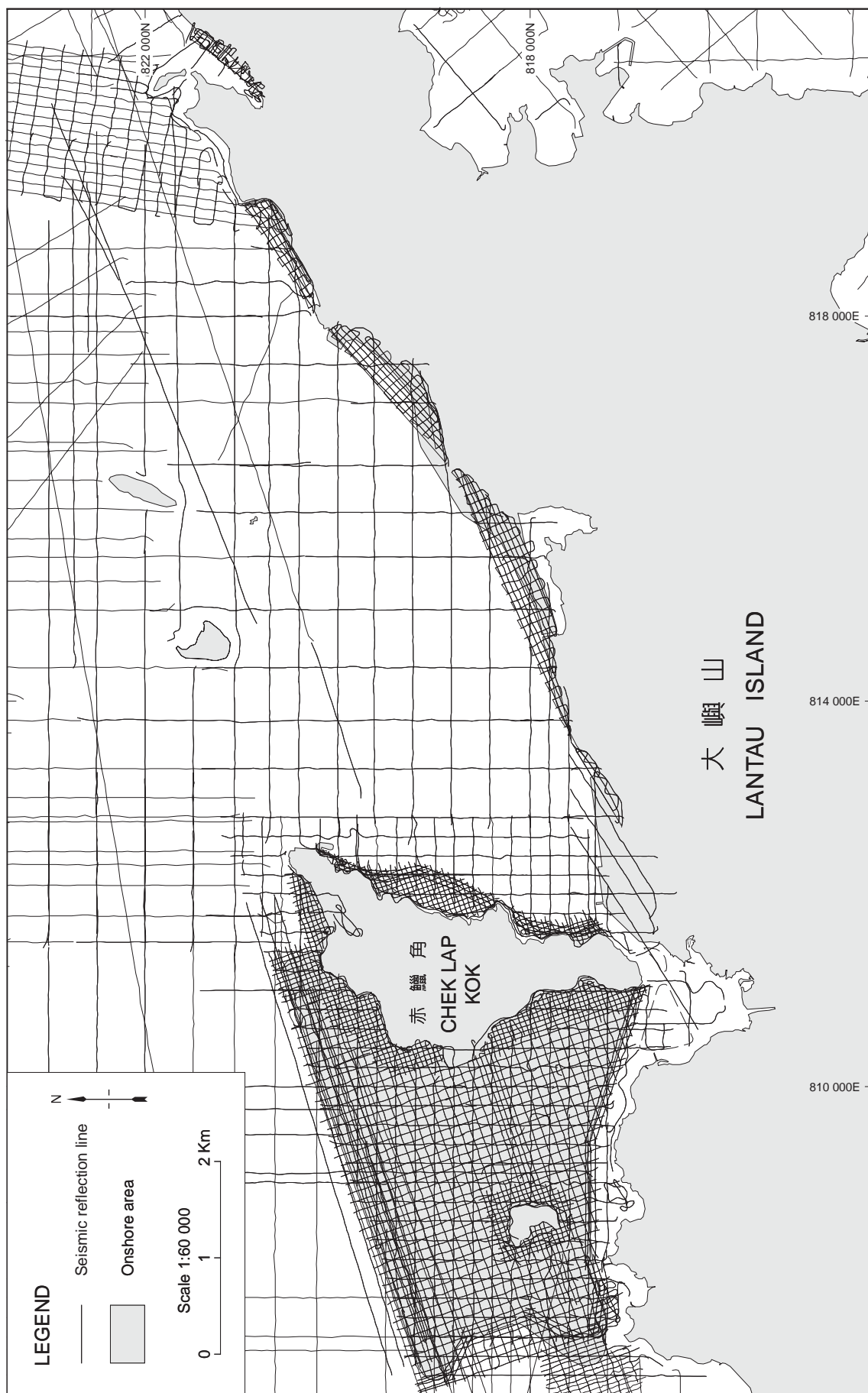


Figure 4 - Locations of Seismic Lines around Northshore Lantau Island