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Development and application of underground space use in Hong Kong

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ABSTRACT

Underground space has been utilised in Hong Kong for many decades. It has been developed through various phases of infrastructure development and improvement. The early forms of underground space construction were associated with war time protection and mining operations and this has extended with increased urban densification to numerous examples of underground basements that have incorporated car parks, retail and commercial underground spaces. Notable underground space also includes numerous road, rail and utility/service tunnels that comprise a network of over 500 km of tunnels in the city to accommodate essential services and transport. With the Mass Transit Railway (MTR) construction in the 1970s it kicked off a spate of excavation of underground space for metro stations and linking tunnel networks that has developed one of the most efficient and reliable metro systems in the world. The private sector has increasingly, over the last few decades, linked their commercial and retail properties to the MTR station network providing hubs of interest and commerce within the underground network. Since the 1990s, a few government "Not-In-My-Backyard" type facilities have been built in rock caverns to meet the needs of the community, including a sewage treatment plant, a refuse transfer station and an explosives depot.

1. Introduction

The challenge of providing useable land within the city's rugged terrain, while still trying to accommodate various competing needs and requirements, is promoting an increased awareness and interest in developing underground space. Hong Kong covers a land area of about 1110 km^2, of which only about 24% (PlanD, 2014) of the land has been developed. The remainder of the land in the city comprises predominantly woodland/shrubland/grassland/wetland (about 67%) with the remaining 9% comprising agricultural, water bodies and some barren land. About 40% of the total land area is designated as country parks. As a result of various competing demands for land from different users, as well as an increased desire to protect our existing landscapes, there is a shortage of land for further urban expansion. At the end of 2014 the city had a population of 7,221,800 which combined with the current extent of developed areas in the city gives an average population density of developed land areas of around 27,000 people per square kilometre. The city has excelled at the construction of high rise buildings for living spaces and in many areas the height limits and development potential has been reached with limited scope to build higher. In recent years, the Hong Kong Government has been actively exploring the potential of underground space development as a viable option of enhancing utilisation of land resources for a dense urban city. This paper outlines the different types of underground space in Hong Kong and how the use of underground space has evolved over times.

A major constraint on normal surface development is the city's steep terrain (Fig. 1) with hilly terrain comprising about 60% of the area of Hong Kong. Steeper terrain with slope gradients greater than 30° accounts for about 35% of the city.

The underlying igneous rocks account for about 85% of the rocks found in the city. Granitic (35%) and volcanic (50%) rocks (Fig. 2) make up the major portion of the surface rock formations. There are other rock formations comprising meta-sedimentary and sedimentary rocks but these typically lie in the low lying terrain areas.

With the high property values for residential buildings (Kowloon & Hong Kong Island) typically between US$14,000 and US $33,000 per square metre (end 2014) the potential to pay for and utilise underground space is becoming increasingly attractive and viable. Indeed retail rents in some of the congested urban shopping areas are in excess of US$50 per square metre.

Hong Kong has a sub-tropical climate that tends towards being temperate for nearly half the year in autumn and winter. Summer months can be very hot with occasional mid to low 30 °C being encountered with high humidity (Fig. 3). The city has periods of

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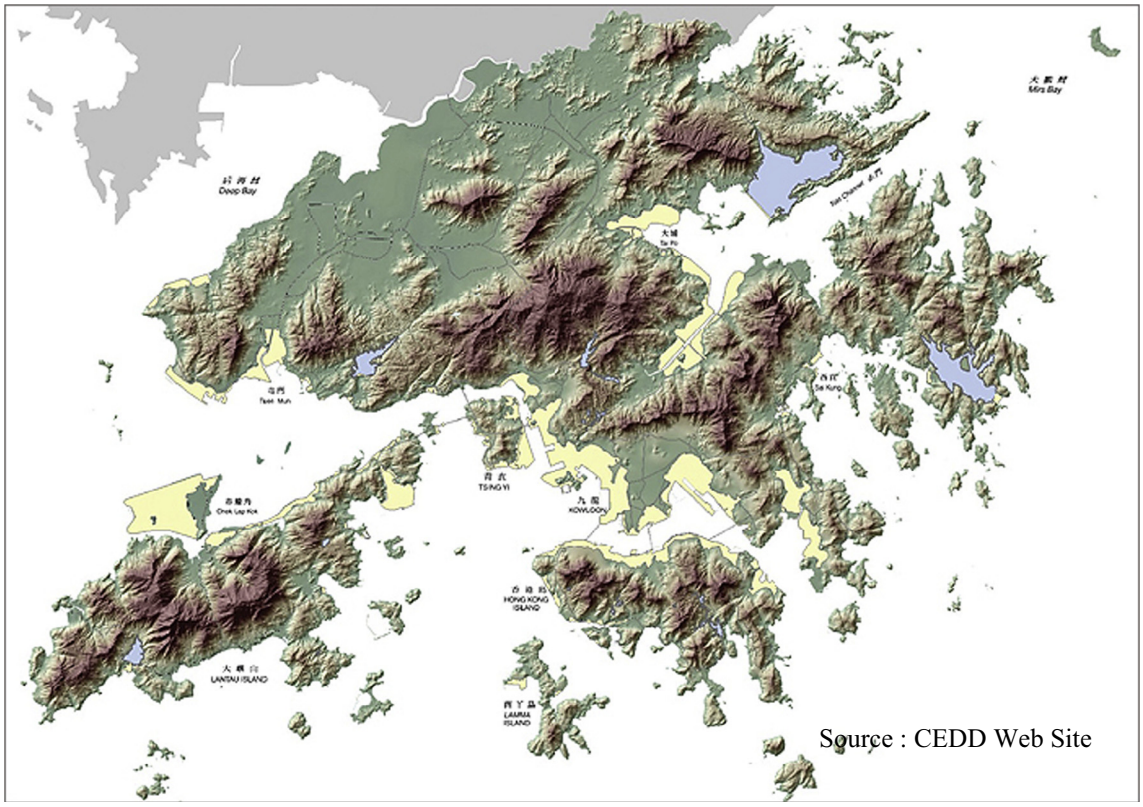

Fig. 1. Terrain map of Hong Kong.

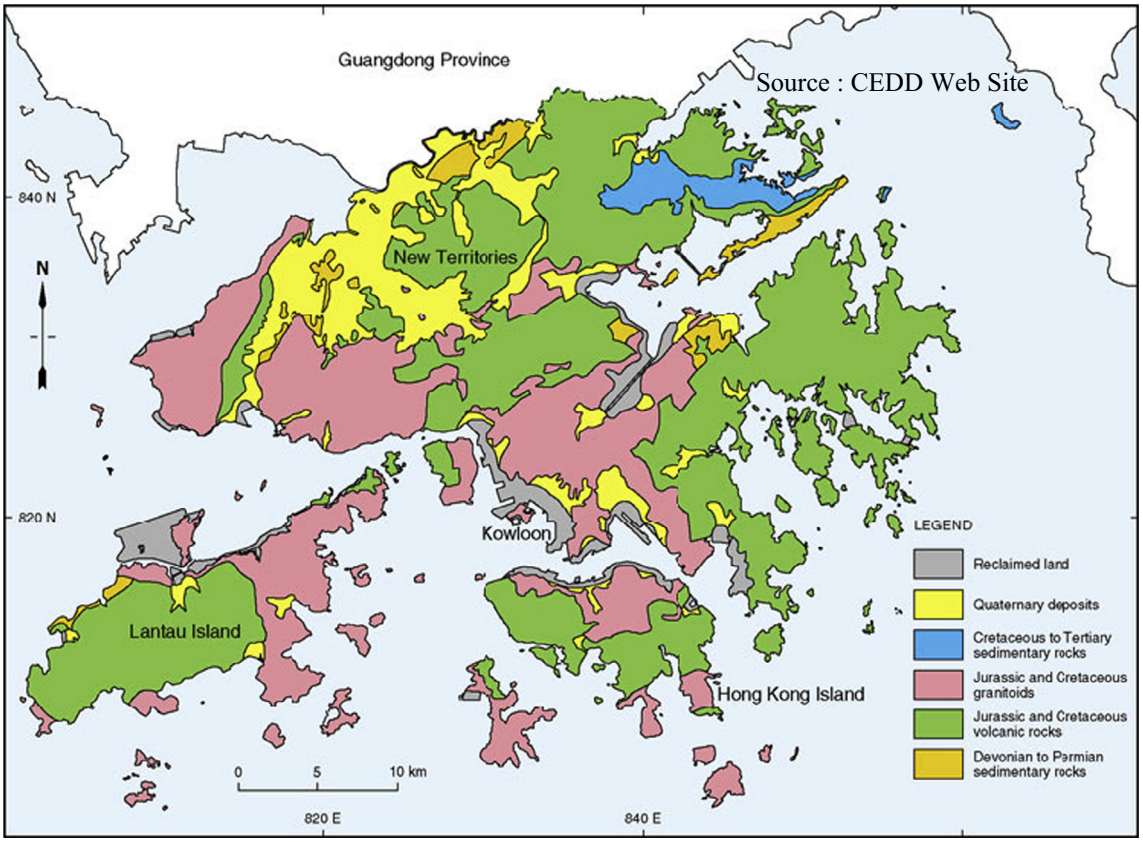

Fig. 2. Simplified geology map of Hong Kong.

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