

Landslides in Hong Kong

The role of clay minerals

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In August 1995, following the torrential rainstorms of Typhoon Helen, a series of more than 70 landslides were triggered in Hong Kong Island, some causing fatalities, injuries and damage to property.

The Geotechnical Engineering Office (GEO), Hong Kong undertook forensic investigations at some of the major sites and as part of this programme, the BGS were commissioned to carry out a series of integrated mineralogical and micro-textural studies of samples from the landslides.

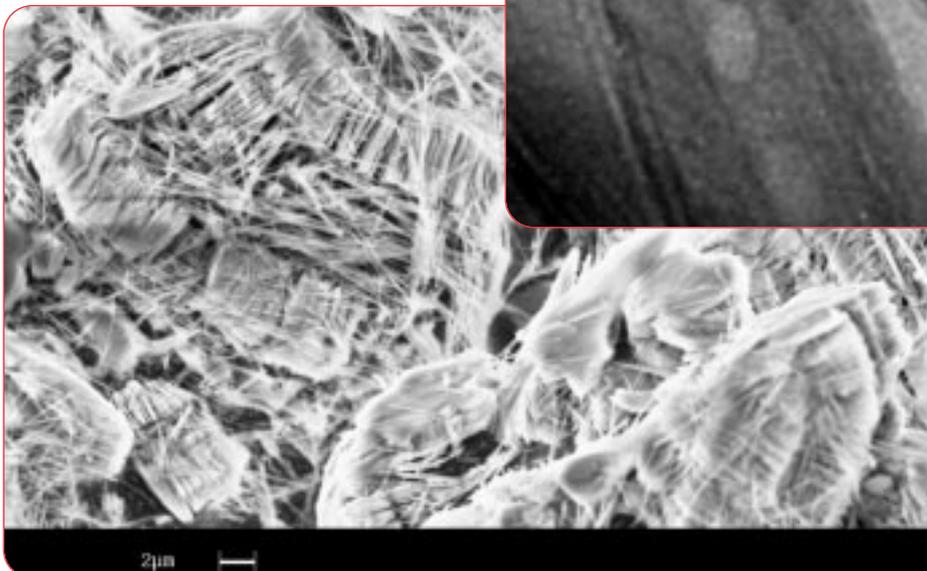
The bedrock includes granite and pyroclastic rocks which are extensively decomposed to a saprolite often rich in kaolin-group minerals. Moreover, in some landslides the rupture surfaces appear to have developed preferentially along zones of abundant kaolin-filled veins and fractures.

Two kaolin-group minerals, kaolinite and halloysite were found in the saprolite. Both minerals have similar chemistries and a relatively simple 1:1 layer structure but halloysite possesses an additional layer of poorly bound water. It is the presence of this layer of water which is, in part, responsible for the more plastic engineering behaviour of halloysite-bearing rocks. The results of X-ray diffraction analysis of

formamide-treated samples indicate that the proportion of halloysite was greater in samples of kaolin-filled joints. But how do halloysite and kaolinite relate to one another?

In situ microtextural relationships were observed in 'field-moist' samples using cryo-scanning electron microscopy (SEM), which minimises damage to delicate clay mineral crystals during imaging. Kaolinite occurs as relatively coarse-grained 'books' of hexagonal plates, often forming vermicular stacks. In contrast, halloysite occurs as fibres replacing the kaolinite. Precipitated crusts of iron and manganese oxyhydroxide were also observed. High magnification studies using a transmission electron microscope (TEM), reveal that the halloysite fibres are in fact tubular crystals possibly formed by the curling of kaolinite plates.

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Above: TEM image of halloysite tube formed by curling of a kaolinite-crystal.

Left: Cryo-SEM image of kaolinite 'books' and halloysite tubes.