
Coal mining and ground surface subsidence at Batu Arang, Negeri Selangor Darul Ehsan

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Coal mining has been carried out at Batu Arang for some 45 years, from 1915 to 1960, with both surface and underground workings. The coal was mined from two main seams; the Upper Seam (some 15 m thick) and

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the Lower Seam (about 8 m thick). These seams, which are stratigraphically some 65 m apart, are interbedded with shales, clays, siltstones and sandstones of a Late Oligocene to Miocene age that have been termed the "Coal Measures". These gently dipping sedimentary rocks outcrop in the form of a plunging syncline and unconformably overlies meta-sedimentary rocks of mainly quartzites and phyllites of an Upper Palaeozoic age. The "Coal Measures" are unconformably overlain by a probable Pleistocene sequence of boulders, pebbles and sub-angular fragments of quartzite in a sandy to gravelly matrix that have been termed the "Boulder Beds". The strata of the "Coal Measures" are cut by a few normal faults and contain closely spaced joints that are mostly developed perpendicular to bedding.

Mapping of past and present features of ground surface subsidence, including depressions and sinkholes (pits), and their effects on man-made structures, shows that their development is closely related to the underground coal workings. Depressions have developed as a result of the gradual down-warping (or convergence) of overburden into underground openings, whilst sinkholes have formed where the caved overburden material has been able to move laterally into adjacent openings.

The most recently occurring depressions and sinkholes have developed over the shallower, earliest underground coal workings, as well as those made during the Second World War, and in a few cases, over some post-War workings. Depressions and sinkholes developed in earlier periods also show a similar relationship and this is to be expected in view of the limited roof support and stowage in the underground workings. In some cases, depressions and sinkholes have developed over bricked or timbered workings.

Several factors are responsible for the development of the depressions and sinkholes, though the most important factor has been the decrease (with time) of the strengths of the coal seams and overburden materials. In view of this temporal relationship, it is considered that several sites in the area will continue to be affected by the development of depressions and sinkholes.