CERAMAH TEKNIK TECHNICAL TALK

Groundwater investigation: Fundamental and application

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Date: 1 March 2023
Platform: Microsoft Teams

Accounting for approximately 99% of all liquid freshwater on Earth, groundwater has the potential to provide societies with tremendous social, economic and environmental benefits and opportunities. Excessive groundwater withdrawal has led to land subsidence or seawater intrusion in many areas of the world. However approximately around four billion people live in areas that suffer from severe physical water scarcity for at least one month per year. Increasing water demand has led to an increase in groundwater investigation and exploration and a strong increase in groundwater withdrawal. In this regard the field of hydrogeophysics has emerged in the late 1990 demonstrating the benefits hydrogeophysical studies can bring for subsurface investigation. This presentation will discuss the importance of groundwater and go through fundamentals of groundwater investigation, defining key properties before presenting case studies in Brunei Darussalam using geophysical techniques.

Organized by:
Geophysics Working Group
Geological Society of Malaysia

Characterizing weathering profiles in Peninsular Malaysia

Dr John Kuna Raj
Date: 15 March 2023
Platform: Zoom

The above talk was delivered by P. Geol. Dr John Kuna Raj (Consultant) on 15th March, 2023, via Zoom. Some 65 members participated. An abstract of the talk is given below:

Characterization of weathering profiles has usually involved their differentiation into weathering zones based on morphological criteria, akin to descriptions of pedological soil profiles. Several criteria have been employed and include colour, degree of preservation of original bedrock minerals, textures and structures, and the shape and percentage occurrence of litho-relicts (core-stones and core-boulders). The weathering zones can serve as engineering geological mapping units and can also assist site investigations through the assignment of engineering characteristics to each zone and the possibility of reducing the number of boreholes and in situ and laboratory tests.

The use of weathering zones for geotechnical purposes, however, has been criticized on the grounds that their recognition is based on qualitative or pedological criteria, criteria that are not quantitative nor related to mechanical properties or engineering behavior of material. It was thus proposed that different grades of weathered rock be recognized; each grade representing a different stage, or combination of stages of weathering of both rock material and rock mass. Recognition of distinct weathering grades in the rock mass was to be based on the degree of discoloration, the rock/soil ratio and the presence or absence of original rock texture.

A review of several classifications of weathering profiles pointed out that core-boulders were not present in all profiles and was critical of the way in which the term ‘grade’ was used both to describe a stage of weathering of rock material as well as classify a zone of weathered heterogeneous rock mass. It was thus proposed that the term “weathering zone” be used to distinguish the character of material en-masse, while the term “weathering grade” is used to describe material from which the mass is formed.

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Recent work in Soil Science has advocated application of the pedo-weathering profile; a synthetic paradigm melding pedological and geological profile concepts. The pedo-weathering profile is defined as being the vertical section that extends downward through the zone affected by sub-aerial weathering, including the soil profile, to the unweathered, unconsolidated or consolidated rock.

In Peninsular Malaysia, deep weathering profiles are found over different bedrock and have developed as a result of prolonged sub-aerial exposure throughout a larger part of the Cenozoic era. Weathering profiles in acidic and intermediate igneous bedrock areas can be differentiated into three broad zones i.e., an upper pedological soil (zone I), an intermediate saprock (zone II) and the lower bedrock (zone III). The upper zone I comprises A, B and C soil horizons and is up to some 15 m thick, whilst the intermediate zone II is up to about 50 m thick and consists of medium to very dense, gravelly silty sands with distinct relict bedrock minerals, textures and structures. Core-boulders are often found towards the bottom of zone II, whilst zone III consists of continuous bedrock with effects of weathering along and between discontinuity planes. Rock mass weathering grades can be assigned to the weathering zones; the pedological soil being Grade VI, and the bedrock, Grades I and II, whilst the saprock comprises Grades III, IV and V.

Weathering profiles over other bedrock types in the Peninsula are quite distinct from those over acidic and intermediate igneous bedrock in view of two main factors i.e., differences in mineral composition and texture, and differences in genesis. Differences in mineral composition and texture give rise to different rates and extents of alteration of bedrock minerals in view of their varying stability under atmospheric conditions. Minerals in ultrabasic and basic igneous bedrock for instance, are altered more completely than those in acidic and intermediate igneous bedrock. Mineral grains in sedimentary and meta-sedimentary bedrock, however, are relatively stable under atmospheric conditions and do not completely alter as those in basic and ultrabasic igneous bedrock. Differences in bedrock genesis influence the processes of weathering that occur as in the case of igneous rocks whose decomposition mainly involves chemical processes due to their constituent minerals that crystalize out at high temperatures. In the case of sedimentary and meta-sedimentary bedrock, however, processes of physical weathering are more important in their disintegration in view of the stability of their constituent minerals and their formation through the compaction, consolidation and cementation of sediments as well as directed stresses.

Weathering profiles over ultrabasic and basic igneous bedrock can be differentiated into three broad zones i.e., an upper pedological soil (zone I), an intermediate saprock (zone II) and the lower bedrock (zone III). Zone I can be separated into A, B and C soil horizons and is up to 4 m thick, consisting mainly of brown, soft to stiff, clays. Zone II is some 2 to 5 m thick and consists of brown, very stiff, sandy silt with many lateritic concretions. Zone III is an outcrop of bedrock with effects of weathering along discontinuities. Rock Mass Weathering Grades cannot be applied to these profiles in view of the absence of their defining criteria, including the absence of discoloration, relict textures and core-boulders as well as inability to apply rock/soil ratios (due to a distinct rock-soil boundary.

Weathering profiles in meta-sedimentary bedrock areas show a great deal of vertical and lateral variability in weathered materials due to their inter-layered nature and inherent lithological, mineral. textural and structural differences. Weathering profiles over quartz-mica schists (and interbedded phyllites and quartzites) can be separated into two broad zones; an upper pedological soil (zone I), some 2 to 6 m thick and the lower saprock (zone II) that is more than 15 m thick. Zone I mainly consists of firm to stiff, silty to sandy clays, often containing lateritic concretions, and can be separated into A, B and C soil horizons. Zone II consists of in situ, moderately to highly weathered quartz-mica schists (or phyllites and quartzites) with distinct relict minerals, textures and structures and marked by alternating bands ofvariously colored, stiff to hard, clayey to sandy silts, and medium dense to very dense, sands. Rock Mass Weathering Grades cannot be applied to these profiles in view of the heterogeneity of the weathered materials and absence of their defining criteria, particularly the inability to apply rock/soil ratios (due to non-existent fresh bedrock outcrops) and lack of core-stones.

Weathering profiles in sedimentary bedrock areas show a great deal of vertical and lateral variability in weathered materials due to their inter-bedded nature and inherent lithological, mineral, textural and structural differences. Weathering profiles over inter-bedded sandstones, siltstones and shales can be separated into two broad zones; an upper pedological soil (zone I), some 2 to 6 m thick and the lower saprock (zone II) that is more than 15 m thick. Zone I mainly consists of firm to stiff, silty to sandy clays, often containing lateritic concretions, and can be separated into A, B and C soil horizons. Zone II consists of in situ, slightly to moderately and highly weathered strata with distinct relict textures and structures and marked by alternating bands of variously colored, firm to stiff and hard, clays and clayey silts, and loose to very dense, sands. Rock Mass Weathering Grades cannot be applied to these profiles in view of the heterogeneity of the weathered materials and absence of their defining criteria, in particular the lack of core-stones and inability to apply rock/soil ratios (due to non-existent fresh bedrock outcrops).

In conclusion, it is recommended that discussions on, and characterizations of, weathering profiles in Peninsular Malaysia take into consideration the following points:

1. weathering grades must strictly only be applied to weathering of rock masses,
2. differentiate between weathering of rock material and weathering of rock mass,
3. recognize differences in genesis of bedrock - igneous, metamorphic and sedimentary,
4. recognize differences in bedrock mineral compositions and textures,
5. grades can only be applied to weathering profiles over acidic and intermediate igneous bedrock,
6. grades cannot be applied to weathering profiles over other bedrock as their defining criteria are not present (especially inability to apply rock/soil ratios and absence of core-stones), and
7. better to characterize weathering profiles in terms of the pedo-weathering profile concept for sub-divisions can be based on geological processes with bedrock applied in a geological sense.

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Tan Boon Kong
Chairman, Working Group on Engineering Geology
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