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Editorial Note

A snapshot of techniques and approaches applied in geological sciences

The 79th volume of the Bulletin of the Geological Society of Malaysia comprises eight original research articles that touch on techniques and approaches in geological sciences, some with potential for wider application. The lead paper by Misman *et al*. (2025) introduces drone technology for investigating coral reefs in Pangkor Island, Perak. The use of images from drone technology has immense potential to be advanced, for example in the study of fast and slow onset hazards. Zulkipli *et al*. (2025) deployed the portable Raman Spectrometry for the first time to analyse mineralogical properties of ancient pottery in Kuantan, Pahang. In combination with the conventional X-Ray Diffraction, the technique provided new insights on the manufacturing process, firing conditions and provenance of the artifacts. A novel approach for assessing flood risks associated with post-earthquake settings has been proposed for Kota Belud, Sabah by Sharir & Roslee (2025). The method draws on hydrodynamic modelling to identify areas at risk of floods and levels of vulnerability, to delineate communities that require enhanced resilience building.

A combination of approaches was used to characterise subsurface karstic conditions by Nguyen *et al*. (2025) in Hanoi, Vietnam. The approach is useful to develop long-term strategies for mitigation and early warning of land subsidence in the densely populated areas. Ostadi *et al*. (2025) used the TRUST Index to determine the vulnerability status of coastal groundwater wells in Terengganu. Further investigation is required to establish the hydraulic characteristics of this coastal aquifer system and assess risks due to saltwater intrusion. The next batch of papers are on structural geology and sedimentology. Choong *et al*. (2025) draw on the K-Ar Age dating method to investigate deformation events in the Bentong-Raub Suture Zone in Peninsular Malaysia. Sedimentological analysis of outcrops in Miri, Sarawak and Brunei Darussalam was used to establish the relationship between lithofacies and depositional settings by Rahman *et al*. (2025). In the last paper of this volume, Pirot *et al*. (2025) uses microscopic analysis to characterise reservoir properties from surface outcrop samples in Iraq, which are comparable to results from scanning electron microscopy and core plug analysis. The following sections provide highlights from the deployment of these techniques and approaches.

Misman *et al*. (2025) used drone technology for investigating coral reefs in Teluk Segadas, Pangkor Island, Perak, to overcome challenges associated with conventional methods and paucity of spatial information. The presence and density of coral reefs were determined based on 330 aerial images combined into a single orthophoto image, which were captured using a DJI Pro Mavic 2. Segmentation and classification techniques were then deployed on the orthomosaic image, to reveal five classes, comprising live coral, dead coral, sediment, coral rubble, and rock. The use of images from drone technology has further potential to be combined with sediment analysis and other parameters for improved insights of the coral reef environment. Drones are an emerging cost-effective tool for conducting photogrammetry analysis in the environment, agriculture, and health domains, where accurate spatial data is required. Published scientific studies using drones are limited in Malaysia, making this an important technique to be advanced.

Zulkipli *et al*. (2025) applied X-Ray Diffraction and the portable Raman Spectrometry (pRS), to determine mineralogical properties and provenance of ancient pottery from the Gua Sagu archaeological site in Kuantan, Pahang. Six earthenware pottery shards from the site and material from the surroundings were analysed. The pottery and clay samples comprise primarily quartz, hematite, muscovite, albite, microcline, and kaolin, while gypsum and hydroxyapatite are detected in the soil samples. The Gua Sagu pottery consists of high-grade clay, was sand-tempered and fired in an uneven atmosphere at low temperatures around 650°C or less. It is not associated with material from Sungai Batu but is likely a product of ancient trade sourced for cooking or storage. The study confirmed that the pRS is a fast, easy-to-use, non-destructive technique, which is useful for identifying amorphous materials and providing information on profile depth. The combination of X-Ray Diffraction and pRS techniques provided new insights on the manufacturing process and firing conditions as well as the origins of the ancient pottery of Gua Sagu.

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Sharir & Roslee (2025) explore the relationship between earthquakes and flood risk in Kota Belud, Sabah. Earthquakes have caused landslides, and in combination with intense rainfall, debris flows have destroyed watersheds, altered the morphology and flow of rivers, including making riverbeds shallow due to sediment deposition, resulting in increased flooding in downstream areas. A comprehensive integrated post-earthquake Flood Risk Assessment model is proposed for Kota Belud, Sabah, which is prone to floods due to rapid development, after the 2015 Ranau Earthquake. Flood Hazard Assessment was conducted using the HEC-RAS hydrodynamic model and flood vulnerability indices and authenticated using bivariate statistical analysis. The density of Flood Risk Elements is highest near the main rivers, specifically Sg. Kadamaian, Sg. Wariu, Sg. Tempasuk, Sg. Abai and Sg. Gurong-Gurong. Flood Vulnerability Assessment reveals that only half of the study area is moderately vulnerable. Areas with high flood hazard and vulnerability levels also have elevated levels of flood risk. These include Padang Pekan, Kg Lilud, Kg Sangkir, Kg Jawi-jawi, Kg Kota Bunga, Kg Limatok and Kg Tamau. The preparedness and resilience levels of communities in this area need to be strengthened.

Nguyen *et al*. (2025) provide an account of land subsidence in the densely populated districts of southwest Hanoi, Vietnam. The area is underlain by five distinct layers. The upper layer comprises Quaternary sediments and the base is composed of limestone, with transgressive and regressive processes influencing the intermediate strata. Multiple approaches were used to establish the geological, hydrogeological, and engineering geological properties of the area. These include data collation from previous studies, field investigation, inputs from the local population as well as electrical resistivity surveys and drilling in areas where land subsidence have occurred. The results link incidents such as collapsed houses and cracked walls to subsurface karstic conditions at depths ranging from 40.0 to 42.5 meters. The increasing frequency of collapses is due to human activities including groundwater extraction. The findings are important to develop long-term strategies for appropriate planning, mitigation, and early warning in areas with similar geological conditions in other parts of the city.

Ostadi *et al.* (2025) determined the hydraulic characteristics and assessed vulnerability of coastal groundwater wells in Terengganu, where water quality and availability from coastal aquifers is an increasing challenge. The assessment was based on the TRUST Index, which considers lithology, river proximity, well usage, distance from the shoreline and well type. The study involved 20 groundwater wells used for multiple purposes, including agricultural, commercial, industrial, and domestic functions; located in eight distinct river basins along the coast. The study deployed in situ sampling and real-time measurements, including constant rate pumping tests performed on four selected wells. Of the 20 groundwater wells assessed, four are categorized as having low vulnerability with relatively sufficient quality and availability of groundwater, while seven are moderately vulnerable, indicating a moderate level of potential risks. The remaining nine wells are classified as highly vulnerable, implying a greater susceptibility to potential threats. The seawater impact reduces further inland; but groundwater wells adjacent to rivers exhibit higher salinity, possibly due to saltwater intrusion, emphasizing the need to improve understanding of these relationships in coastal aquifer systems.

Choong *et al*. (2025) investigate deformation events in the Bentong-Raub Suture Zone (BRSZ), informed by K-Ar Age dating of selected rocks. Field observation and analysis of fractures, bedding and other features along two transects in the Lojing and Pos Betau areas, was supplemented with data from previous work to produce structural maps. A schistose granite in the Lojing area and andesitic rock in Pos Betau, both exhibiting dextral shear movement, were dated using the K-Ar method. Three structural events are interpreted across the BRSZ. An initial east-west shortening (D1) was followed by a dextral shear trending north-south (D2), and a consecutive northwest-southeast extension (D3). The schistose granite and andesitic rocks, which exhibit features of structural reactivation by the dextral shear (D2), are dated as 100 Ma (biotite) and 91 Ma (whole rock). The initial event is correlated to the Indosinian Orogeny's compressional event, followed by a reactivation of its structures in the late Cretaceous. The presence of normal movements in a predominantly northwest-southeast direction represents a post-D2 relaxation period. This is linked to the adjacent granitic batholith, regional basin development and alterations associated with the Sunda Plate during the Cenozoic.

Rahman *et al*. (2025) conducted sedimentological analysis of outcrops in Miri, Sarawak and Brunei Darussalam, Northwest Borneo. Nineteen sections comprising sandstone, interbedded sandstone with mudstone and heterolithic rocks were logged, to establish the relationship between lithofacies and depositional settings. Based on the sedimentary structures, two predominant groups of lithofacies were delineated; wave-generated lithofacies and tide-generated lithofacies. The wave-generated lithofacies, consisting primarily of planar, swaley, and hummocky cross-stratified sandstone, were subdivided into five associations; representing the foreshore, lower shoreface, middle shoreface, upper shoreface and upper offshore. The tide-generated lithofacies comprising numerous heterolithic structures and herringbone cross-stratified formations; were further classified into lagoon, tidal sandbar sandstone, tidal to sub-tidal sand flat and sub-tidal mud

flat. The regional paleocurrent is interpreted to be in either the northeast or southwest direction, with siliciclastic detritus sourced from the Rajang Group. The study suggests that the primary depositional setting is within the estuarine to shallow marine environment.

Pirot *et al*. (2025) characterise static reservoir of shallow marine carbonate rocks from surface outcrops in northeastern Iraq, to compensate for limited subsurface data. The Late Triassic - Early Jurassic Sarki Formation is approximately 115 m thick, comprising dolomite, dolomitic limestone, recrystallized breccia, and thin beds of marl. A total of 36 samples were collected at every change of lithology and colour of the logged section. Reservoir properties including type, size and connectivity of pores were determined using microscopic analysis involving both normal and blue epoxy treated thin sections; and compared with results from scanning electron microscopy and core plug analysis. Comparable results were obtained from all the methods deployed. The Sarki Formation consists of diverse pore types with porosity ranging from 2 to 9.5%, and permeability averages of 0.01 md to 0.13 md, from the lower to the upper parts. The porosity and permeability are negligible to fair, with the lower and middle parts of the formation displaying poor reservoir characteristics compared to the upper part. The potential of the Sarki Formation as a petroleum reservoir is limited, particularly at the lower and middle parts.

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