

Editorial Note

Emerging areas of geology research in Southeast Asia

I am pleased to present the 78th volume of the Bulletin of the Geological Society of Malaysia, which comprises eight articles, in line with our aim to promote advancement of the geological sciences. Nearly six decades of knowledge generated within the country and Southeast Asia have been documented in the Bulletin and its sister publication, *Warta Geologi*. There have been four volumes of bibliography and index of all scientific papers in the Bulletin and *Warta Geologi* between 1967 and 2004. In this issue, the grand tradition of documenting expands to record emerging areas of geology research.

The lead paper by Khoong *et al.* (2024) is a seminal effort to analyze advances in geology and delineate emerging areas in Southeast Asia between 2018 and 2022, using a digital approach. It appears that Indonesia and Malaysia are the most significant contributors of geology knowledge as indexed by the Scopus database during this period, and emerging geology research areas relate to the natural gas, environment, and tourism sectors as well as machine learning and sustainable development. The second paper by Sonie *et al.* (2024) applies mineralogical and geochemical techniques to make a significant contribution to archaeological records on traditional Malay pottery-making. Historical heritage plays a huge role in developing tourism, and the added insight to these artifacts is important for the sector; an example of an emerging area of geology research. The next two papers by Salimun & Mohamad (2024) and Salman *et al.* (2024) can be clustered under the conventional topic of engineering geology. This is followed by another two papers by Ishak *et al.* (2024) and Fong *et al.* (2024) that relate to depositional environments. Kessler *et al.* (2024) introduce the subject of hydrocarbon biodegradation in the Malay Basin. The final paper from Mina & Abdula (2024) showcases techniques used in Iraq to characterize source rocks and establish their linkages.

Khoong *et al.* (2024) conducted an assessment of recent advancement in geology and delineated research gaps in 10 countries of the Association of Southeast Asian Nations (ASEAN). A bibliometric analysis using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) technique was deployed in conjunction with the VOSviewer software for visually representing patterns and trends of the data. This involved identification, screening, and stepwise review of the eligibility of publications indexed by the Scopus database, followed by visualisation and pattern recognition. The Scopus database was selected for the quality of its publications and its recognition as the most widely indexed abstract and citation database for research. The analyses of 2,319 articles revealed that the number of articles published annually between 2018 and 2022 ranged from 265 to 585 at its peak. Categorisation of the five most frequently terms yielded seven distinct clusters. These are geology, structural geology, seismology, economic geology, deposits, engineering geology and volcanoes, with significant contribution from Indonesia and Malaysia. Emerging research areas that have been discerned are gas engineering, environmental technology, tourism, machine learning and sustainable development.

Sonie *et al.* (2024) used mineralogical and geochemical attributes of prehistoric pottery of Bukit Komel in Sungai Tembeling, Pahang, to gain insights on its physical characteristics, technology, and provenance. The methods employed include X-ray diffraction, X-ray fluorescence, thin section petrography, and microscopy examination using 3D imaging. The shapes of the Bukit Komel pottery include flat- and round-bottomed vessels with plain, red-slipped, impressed, and incised designs. The pottery was hand-made using the paddle and anvil technique and sand-tempered. An analysis of the colour reveals that it was very likely fired using the open-firing technique at low temperatures, perhaps between 400°C and 600°C. Findings indicate that the Bukit Komel pottery was locally made by using clay sourced from Sungai Tembeling. Both the pottery and clay extracted from Sungai Tembeling have similar minerals including quartz, albite, muscovite, and microcline. This discovery is a significant addition to archaeological records on traditional Malay pottery-making in Ulu Tembeling.

Salimun & Mohamad (2024) report on the mechanical behaviour of soil-rock mixture (SRM) from the weathered granitic hill of Lumut, Perak. The study used sieve analysis, specific gravity, compaction, and direct shear box tests to determine the shear strength parameters of weathered SRM with particle size distribution. The initial sample was separated into well-graded, poorly-graded, and gap-graded types of particle size distribution with 30%, 50%, and 70% rock block

content, respectively, for further analysis. The specific gravity, dry density, optimum moisture content, and estimated porosity values show a considerable difference in relation to particle size distribution and rock block content. The well-graded SRM indicates non-linear relationships for both cohesion and friction angle values. In poorly-graded SRM, the cohesion decreases as the rock block content increases and inversely has an increment of friction angle. The gap-graded SRM shows increases in the cohesion when the rock block content increases. The findings of this study contribute to improving understanding of the changes of shear strength parameters with particle size distribution and rock block content. The information is useful for evaluating the stability of slopes with SRM for improved designs.

Salman *et al.* (2024) investigated the karst architecture and geometry of carbonate reservoirs in the Central Luconia Province, offshore Sarawak, Malaysia, which may have a detrimental impact on drilling operations. The 3D seismic and well data of the Jx carbonate platform was used to analyse the interrelationship between karsts and faults, determine attributes for the geomorphology of the karst surfaces, and conduct a comparative study with the Niah Caves, Miri, Sarawak, located 268 km away. The Automatic Fault Extraction (AFE) module application combined with the manual fault-picking technique in the PaleoScan 2022 software were used to interpret major fault lineaments. Two attributes, seismic relief and dip, were extracted from four main horizon surfaces to distinguish the karst features and define the structural morphology of karsts. Findings revealed that the most common karst features observed were dendritic karst networks and karst collapses or sinkholes, represented by discontinuity form and synclinal expression (high dip magnitude). Digital elevation model maps and fieldwork revealed that most of the delineated karst features observed in the Niah Caves are similar to those discovered in the Jx field but with varying dimensions. Further work has been suggested for assessing features with potential threats to delineate low-risk regions for drilling programs.

Ishak *et al.* (2024) reviewed the palynological records in Late Cenozoic succession from the Temana Field of Balingian Province, offshore Sarawak. The reinterpreted data from two wells confirmed three distinct palynological assemblage zones. Zone-1 is dated as Late Oligocene, characterized by abundant *Florschuetzia trilobata* and dominant montane and seasonal elements such as *Picea*, *Tsuga* and *Pinus*. Zone-2 is of Early to Middle Miocene, dominated by Kerapah *Casuarina*-type pollen and characterized by increasing abundance of Rhizophoraceae mangrove pollen. Zone-3 is dated as Late Miocene to Pliocene, occurring above a major angular unconformity marked by a high percentage of the rainforest pollen Rubiaceae and a minor increase in seasonal elements. The presence of predominantly mangrove pollen such as *Florschuetzia* genus and Rhizophoraceae-type indicates that the depositional environment is a marginal marine with brackish water and tidal influence. The paleoclimate varies from a seasonal and dry climate with montane forest in Oligocene, to warm and everwet conditions during the Early to Middle Miocene, represented by the Kerapah peat swamp. The humid climate continued until Late Miocene to Pliocene with minor intermittent seasonality.

Fong *et al.* (2024) studied the Tukai Formation in northwest Sarawak, Malaysia, to better understand its paleo-ecological history and depositional environment. Field investigation was supplemented with palynomorph examination of 15 samples of the Tukai Formation, comprising intensely bioturbated sandy mudstone and organic-rich mudstones. Findings indicate that the landscape during deposition of the Tukai sediment is marked by diverse vegetation, including hinterland, front and back mangroves, and montane regions. *Rhizophora* type, *Laevigatosporites* sp., *Elaeocarpus* type, Euphorbiaceae, and *Verrucatosporites usmensis* (Stenochlaena) dominated the pollen assemblage.

Kessler *et al.* (2024) assess oil characteristics, the effects of biodegradation on oil reservoirs, and its implications on petroleum production in the eastern Malay Basin, offshore of Peninsular Malaysia. The assessment was based on oil data and parameters from thirteen eastern Malay Basin flank accumulations. The findings revealed a great variety of oil types in the eastern Malay Basin flank area. Shallow reservoir levels were associated with heavier, lower quality oil while deeper petroleum reservoirs hosted mostly light oil. The oils are characterised by differing content of wax, fairly low amounts of sulphur and significant levels of CO₂ on occasion. The shallow reservoir oils appear to have been derived from originally light oils that suffered from biodegradation. Compared to the native oils, they are slightly enriched in sulphur. Oils in reservoirs with a temperature of less than 75°C appear to have been biodegraded. Reservoirs with temperatures above 90°C are not affected. Shallow reservoir oils with high viscosity are a potential issue for oil production and recovery. This should be a consideration for all shallow targets (depth < 1280 m below mudline). Further inquiry of problematic oils, including geochemical investigation of reservoir fluids and detailed mapping of these aquifer systems, is suggested to support exploration in the Malay Basin.

Mina & Abdula (2024) conducted a geochemical analysis of rock cuttings and crude oil samples from the Hawler Block, Kurdistan Region, Iraq. A total of 11 rock cutting samples and three samples of crude oil from Z1, Z3 and Z5 wells were analysed for parameters relevant to source rocks to establish their linkages. The total organic carbon content from pyrolysis analyses revealed that the Sargelu and Naokelekan formations can be classified as very good source rocks, while the Najmah Formation is a fairly high potential source rock. The organic matter in the Sargelu and Naokelekan formations show are at a mature stage and within the oil window. The Najmah Formation has organic matter at an immature stage. The Sargelu Formation is oil and gas prone, while the Najmah and Naokelekan formations are oil prone. The relative age of the Sargelu, Naokelekan, and Najmah formations is Middle to Late Jurassic and deposited under moderate saline conditions. The biomarkers indicate that the Sargelu and Naokelekan formations are related to the oils in Z1, Z3, and Z5 wells. There is no link to the Najmah Formation.

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