

GEOLOGICAL SOCIETY OF MALAYSIA

REGIONAL CONFERENCE ON THE GEOLOGY OF SOUTHEAST ASIA

KUALA LUMPUR : MARCH 20-25, 1972

A Report

This report on the Society's Regional Conference was prepared for the Commonwealth Geological Liaison Office, but Council felt that it would be of some interest to members, particularly those who were unable to attend the Conference. Therefore, although a brief report has already appeared in Newsletter No. 35, this extended account is being distributed to all members of the Society.

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REGIONAL CONFERENCE ON THE GEOLOGY OF SOUTHEAST ASIA

Kuala Lumpur, Malaysia, March 20-25 1972

The first Regional Conference on the Geology of Southeast Asia, sponsored by the Geological Society of Malaysia, was held in the Science Faculty, University of Malaya, during the period 20 - 25 March 1972. In addition to the five and one half days of indoor sessions with presented papers, one-day field excursions before and after the sessions covered the geology and the tin mines of the Kuala Lumpur area, while two seven-day excursions after the sessions took more than thirty participants to northwest Malaya and the Langkawi Islands (Cambrian to Triassic sedimentary rocks of the 'Yunnan-Malaya geosyncline') or to central and southeastern Malaya (Lower Paleozoic 'eugeosynclinal' rocks; Carboniferous to Cretaceous sediments and volcanics in a cross-section of the Peninsula). The response to the field excursions was enthusiastic and both week-long trips were fully booked. In conjunction with the Conference, a simultaneous meeting of the Editorial Committee for the Tectonic Map of Southeast Asia and the Far East was jointly convened by the Commission for the Geological Map of the World (CGMW), the United Nations Economic Commission for Asia and the Far East (ECAFE), and the United Nations Educational, Scientific and Cultural Organization (UNESCO).

With a total of 262 registered participants and nearly 50 presented papers, the Regional Conference was a rather larger meeting than the Geological Society of Malaysia had originally envisioned. It was easily the largest - and the most international - geological gathering ever held in Malaysia and certainly one of the largest ever in Southeast Asia. The size of the turnout, which included large delegations from Indonesia (over 50), Australia (20), U.S.A. (13),

Thailand (11), Philippines (9), Japan (8), and smaller numbers from Burma, Vietnam, Cambodia, Taiwan, Ceylon, Afghanistan, and various European countries, in addition to the many participants from Malaysia and Singapore, indicates the intense current interest in Southeast Asian geology, both academic and economic.

The Conference was formally opened by the Deputy Prime Minister of Malaysia, Y.B. Tun Dr. Ismail bin Dato Haji Abdul Rahman, who emphasized in his remarks the role that geology has to play in the economic development of the region. Participants were also welcomed to the University of Malaya campus by the Vice-Chancellor, Professor Ungku Aziz.

The meeting was divided into six sections on various broad topics, but these ran sequentially and never simultaneously. This helped make the meeting a success, as many participants were able to contribute in discussions outside their nominal specialties, and some aspects, particularly the tectonics, were found to be of crucial relevance to other topics.

Section 1, titled "Regional Tectonic Framework", covered the entire first three days of the sessions, and indeed considerations of tectonic patterns and their implications may be said to have permeated and dominated the entire meeting. The keynote address, delivered by Warren Hamilton of the U.S. Geological Survey, dealt with "Plate tectonics of Southeast Asia and Indonesia." Hamilton gave a lucid review of the recent remarkable synthesis known as 'plate tectonics' and of the massive evidence for the reality of this tectonic pattern in the present oceans and island arcs, with special reference to the Indonesian and adjacent arcs. He also attempted to extend the pattern back in time and into the continental geology, where interpretations are more difficult and controversial. There could not, however, have

been a more appropriate keynote address, and much of the remainder of the Conference, including much of the most heated - and educational - discussion, was involved in trying to test the plate tectonics model against the real geology of Southeast Asia, back to Cambrian time, and to explore and test its implications for 'geosynclinal' history, volcanism, plutonism, metamorphism, and mineralization.

At first, however, the plate tectonics model seemed to produce only divisiveness. There seemed to be no common language between those participants who had accepted the model and used its terminology habitually, and those who spoke in classical terms of geosynclines and orogenes. As is often the case in international scientific gatherings, the real "language problem" was not between different vernacular tongues but between different scientific viewpoints and terminologies and was most clearly seen in discussions where all had excellent command of English. But as the discussions went on, concepts were clarified, barriers of terminology broken down, and differences narrowed, so that by the end the participants all seemed engaged in a common endeavour of testing plate tectonics against the real world of Southeast Asian geology. It was not consensus but it was effective communication, and the endeavour will surely be continued by many of the participants in their own areas. The meeting thus had a degree of unity, and plate tectonics was the thread that tied it together.

Following Hamilton's keynote address, various papers on the tectonics of the region were presented. J.A. Katili discussed the geochronology of West Indonesia in the light of plate tectonics. He pointed out that whereas Cretaceous granitic rocks occur in Central and South Sumatra, they are absent in Java, but are found in offshore areas north of Java. The Mesozoic in Java itself is characterised by a subduction mélangé of late Cretaceous age. Hence the volcano/plutonic arc of Cretaceous time so clearly present in Sumatra does not

extend into Java but swings north of it, parallel to the subduction melange. Both zones merge in the Meratus Mountains of Southeast Borneo.

C.S. Hutchison gave a preliminary attempt to interpret the geologic history of Malaya in terms of plate tectonics. This points to a complex history, starting with west-dipping subduction under the present Main Range in Lower Paleozoic, followed by eastward migration of the subduction zone, rifting away of the formerly adjacent craton on the west, and initiation in Triassic time of east-dipping subduction under Sumatra, causing volcanism and plutonism in Malaya. This sketched outline agrees in many points with that of Warren Hamilton, given in his keynote address, save that Hamilton suggested Malaya was "put together" by the collision of two mini-continents joined along a Carboniferous-Triassic suture. Lively discussion following Hutchison's paper brought out the controversial nature of these interpretations, disagreements on the "facts" showing the need for further work.

N.S. Haile, in a paper on the North Sunda Shelf, re-examined van Bemmelen's tectonic zonation of the region, finding the zones in modified form to be real in West Borneo, but their extensions across the South China Sea doubtful. Haile, while accepting the probability of former plate sutures in Borneo, disputed Warren Hamilton's characterization of the Northwest Borneo Geosyncline as being largely a subduction melange, pointing out that it is only locally chaotic in structure, and that it faces toward the Asian mainland.

W.E. Bush reviewed the distribution of mineral deposits of the Thai-Malay Peninsula, concluding that they occur in definite belts of varying composition of the deposits, and that these belts are related to positions in a "normal geosyncline." He felt there was no 'need' to call on plate tectonics. Bush's views aroused some discussion.

R.W. Murphy outlined the inferred history of the Manila Trench - West Taiwan belt, where east-dipping subduction appears to have replaced previous west-dipping subduction in Middle Pliocene time (a "flipped" subduction zone), causing the collapse of an island arc against the continent in Taiwan. Brief down-plunging of continental lithosphere there has now been replaced by strike-slip fault movement.

A number of papers presented detailed information and analyses of selected areas in Southeast Asia. Many of these were based on work connected with oil exploration, and dealt with offshore areas around Indonesia. Included here were descriptions of the southern Sunda Shelf (R.P. Koesoemadinata and A. Pulunggono), which contains a number of Tertiary basins, some quite deep, and hence was not stable like some parts of the Sunda Shelf; sedimentary facies in Java (F.H. Hehuwat) where zonal and sequential arrangements of shallow and deep water deposits are related to the tectonic history; mafic and ultramafic rocks in eastern Sulawesi (Celebes) (R. Suriaatmadja and others) which are associated with other elements of a subduction mélange, including cherts and limestone; the Moluccas (F.A. Gribi, read by R.W. Murphy), a complex area of fossil subduction zones, where petroleum has been shown to exist in Pleistocene bar sands, having its source in underlying Pliocene deep-water clays; geochronology of the Indian shield (M.S. Balasundaram), where the evidence now points to six major events ranging in age from more than 3000 m.y. to 500 m.y.; and structural and volcanic features of west-central Sumatra (M.M. Posavec and others), where volcanic centers are mainly sited at the intersections of strands of the Sumatran Fault System with other lineaments, and the volcanism along these faults seems to be adding vertical layers of new andesitic crust, a possibly important variant of the mid-oceanic ridge style of crustal formation.

In other papers of this section, N.S. Haile and M.W. McElhinny (read by Haile) presented preliminary paleomagnetic data and pointed out the great potential value of paleo-magnetic studies in Southeast Asia, and R.H. Barton gave an interesting analysis of the regional drainage pattern of the Malay Peninsula. Barton concluded that the Pahang River, Malaya's largest, formerly flowed out to the southwest through the present Muar River, into the Malacca Straits, and was captured by an east-flowing stream. Cyclic capture and recapture between the two drainages was indicated. Similar analyses showed migration of the position of the Klang River delta and the possibility of cyclic capture-recapture between the Perak and Kinta Rivers, this last however being disputed by those who have studied the alluvial deposits of the Kinta.

Nearly an entire day was devoted to presentations by representatives of various United Nations and I.U.G.S. sponsored programs. F. Ronner of UNESCO explained the International Geological Correlation Programme. In discussion, J.A. Katili of Indonesia brought up the serious manpower problem of developing countries; with relatively few trained people, for these countries each new such international program they participate in means less basic work (for instance, field mapping) gets done at home. No good solution to this problem was suggested, apart from a half-serious proposal for a moratorium on all such programmes (a "Year of the Quiet Scientist").

F. M. Delany, representing the Commission for the Geological Map of the World, outlined plans for promoting compilation of small scale regional or continental earth science maps. The meeting of the Editorial Committee for the Tectonic Map of Southeast Asia and the Committee's joint participation in the Tectonics Section of the Conference represented part of this effort. J. Marcais, President of the Working Group of the CGMW, then reviewed the preliminary efforts to

agree on a common legend for tectonic maps, pointing out that serious disagreements had arisen on the treatment of "geosynclines". The basic attempt has been to separate orogenic zones of different ages, with the details left to the discretion of the national compiler at this stage.

National tectonic maps, mostly in draft form, were then presented by members of the Consultative Group for the ECAFE Tectonic Map of Asia and the Far East, for Afghanistan, Australia, Burma, India, Indonesia, Iran, Japan, Malaysia, the Philippines and Thailand. A new geologic map (scale 1: 1 000 000) of West Malaysia and Singapore published by the Geological Society of Malaysia was also presented by D.J. Gobbett (this map is available from the Society at M\$4, surface postage included). The various national tectonic maps presented illustrated well the disagreements and problems mentioned by F. Marçais. Wide differences in approach and frames of reference were spotlighted. In particular, the degree to which plate tectonics ideas are incorporated in these tectonic maps ranges from zero to one hundred percent, and those maps that ignore plate tectonics themselves follow various sets of ideas. Some maps are based on assumptions of world-wide orogenic episodes ("Caledonian", "Hercynian", etc.), while others reject this notion. The Australian Tectonic Map, presented by H.F. Dutch, offered a promising approach, rejecting all preconceptions and using, for the shield portion, a division into tectonic "domains" based mainly on the character of the platform cover. But it may be doubted that any one simple scheme will work for both Australia and an area such as Indonesia.

In discussion it was agreed that the only hope for meaningful compilation of tectonic maps over large and diverse regions lay in the use of objective criteria for separating units on the maps. So long as this was done and the criteria clearly defined, differing

philosophies and tectonic theories could coexist in the interpretations made of the objective units. This view was also endorsed in the separate closed-door meetings of the Editorial Committee and Consultative Group, as later reported by L.W. Stach of ECAFE. While plate tectonics ideas could perhaps easily be applied in an active area like Indonesia, their extension into the older continental geology, as criteria for depiction of units on maps, presented many difficulties. It was therefore agreed that the data to be presented on the tectonic map of the ECAFE region should be "as factual as possible", and that the criteria for recognition of former subduction zones, such as mélanges, ophiolites, blue schists, and others, should be clearly expressed on the map. No firm decision on a standard legend could yet be reached.

An open discussion session concluded the three days of consideration of the 'tectonic framework'. N.S. Haile began the session by questioning the characterization of the rocks of the Northwest Borneo Geosyncline as a 'mélange'. In reply, Warren Hamilton conceded that much of the rocks did not fit the classical definition of 'mélange' as a chaos containing large blocks of diverse origin, but he vigorously defended his interpretation of the rocks as imbricately thrust sequences accumulated mainly in a trench at the subduction zone. Perhaps some term other than 'mélange' should be used.

A lively and fruitful discussion ensued. Some geologists working in Indonesia, Malaysia, the Philippines, and India expressed varying degrees of doubt about aspects of the plate tectonics model. Many of these disagreements were matters of terminology and were cleared up quickly, but some represented real differences in interpreting the evidence. Concerning northwest Borneo, it was brought out that the structure seen in at least the northern part of the 'geosyncline' (east-topping beds younging to the west, with numerous

steep faults and shear zones) fits rather well what one would expect to be formed by an east-dipping subduction zone. But the scarcity in these rocks of the traditional 'eugeosynclinal' elements (ophiolites, cherts, abyssal red clays) was pointed out as not being expectable on this model. Hamilton commented on this by saying that he felt the amount of sediment supplied to a trench was an important variable: where little more than rafted pelagic sediment is fed to a subduction zone, this thin layer becomes very highly deformed and shows much involvement of the mantle (ophiolites), while in other cases the large amounts of terrigenous sediment filled the trench to a considerable depth and the resulting pile will, at least in its upper part, show less deformation and less involvement of mantle. Hamilton surmised that the sediments of the Northwest Borneo Geosyncline were supplied by a large abyssal fan (like the present Bengal fan) fed from mainland Asia through the present South China Sea area, and he cited as evidence for this the following:

- (1) the general reduction in volume of the sediment pile from south to north in Borneo and the southwest Philippines;
- (2) northward transport directions shown in the Crocker Formation (Eocene) in Sabah; and
- (3) presence of quartzose sands in Palawan, Mindoro, and Panay, the only part of the Philippines where such sediments not of island-arc derivation are found.

The presence or absence of paired metamorphic belts was discussed, some participants doubting that any were present in Southeast Asia. J.A. Katili and Hamilton then gave examples from Sulawesi and Sabah respectively. C.S. Hutchison pointed out, however, that the 'high pressure metamorphic belt' in northeast Sabah was

based on rare reports of a few isolated outcrops of glaucophane schist. Hamilton replied that if it really was glaucophane schist, even one outcrop was important, since it required about 30 km of overburden for its formation.

When questioned about the expected acid igneous belt accompanying the Cretaceous-Eocene subduction zone in Borneo, Hamilton replied that very sketchy data indicated a large area of granites and acid volcanics in southern Borneo which were of about the right age and in the right position.

This discussion demonstrated both the exciting potential of plate tectonics for unravelling the structure and history of South East Asia, and the problems of its application - problems of uncertainty about aspects of the model, problems of paucity of hard data in some areas, and problems of differing approaches and interpretations.

A new BBC film entitled "Drifting of the Continents" was shown during the tectonic section of the Conference. This film, shown through the courtesy of Gulf Oil Co., beautifully developed and illustrated the evidence for modern ideas of tectonics, including continental drift and plate tectonics.

Section 2 concerned Stratigraphic correlations and paleontology. Nguyen Lan Tu described Permian calcareous algae from Vietnam, Cambodia and Laos, noting Japanese affinities of some newly discovered examples. S.S. Sartono reported a new find of Stegodon in Timor and speculated on the migration routes used by these animals to reach there from the Asian mainland. E.V. Tamesis and others described the late Tertiary history of the shelf off north-western Palawan, Philippines, with the most salient features being unconformities separating the Middle Miocene from the Upper Miocene

and the Miocene from the Pliocene sediments. F. Baum, presenting papers by K.E. Koch and H.D. Maronde, described areas in northern Thailand showing Paleozoic 'geosynclinal' history very similar to that of the Malay Peninsula to the south.

Three general papers on Southeast Asian correlations were read. S.S. Sarkar reviewed the Carboniferous and Permian biostratigraphy of Malaya by means of the sometimes close correlations with strata in the Salt Range, Spiti, and Kashmir. D.J. Gobbett reviewed the Carboniferous and Permian of all of Southeast Asia, and pointed out that while the Lower Carboniferous is closely comparable to that of Europe, the Permian is distinctly Tethyan in character and correlation outside the Tethyan area is difficult. C.G. Adams discussed the zonation of Tertiary carbonate sediments in the Indo-Pacific region. After reviewing existing zonations, including the 'letter stage' scheme, Adams proposed to erect a new zonation based on larger foraminifera. The environmental limitation of using benthonic forms is not so serious, he felt, if one limited oneself to shallow-water carbonates, and if one remembered that dead shells get washed about so that mixing between environments occurs. Adams appealed to participants to provide him with good sampled sections of Tertiary limestones, particularly of "Tf" age.

In a brief section on the geology of continental shelves of the region, S.P. Sivam and B. Biswas presented papers on the sediment distribution and Quaternary history of the offshore areas of Malaya. These papers emphasized the importance of Quaternary sea level fluctuations in producing peat layers, unconformities, and relict sediments on the shelves.

An important paper by G.J.J. Alewa and others (read by E.H. Bon) gave a detailed description of the offshore areas between Singkep and Bangka and around the Karimata Islands in Indonesia. Putting together evidence from a variety of techniques including direct sampling, they were able to present geologic maps, cross sections, and a geologic history as detailed as can be done in many onshore areas. The bedrock is overlain by unexpectedly thick Tertiary sediments of shallow-water and continental type, divided by peat layers and at least one major unconformity, and containing large systems of fluvial channels.

Another brief section on geochronology included just two papers. N.S. Haile and N.D. Watkins (read by Haile) discussed the use of paleomagnetic reversals in dating Quaternary events in Southeast Asia and gave preliminary results indicating that some of the 'Older Alluvium' of Malaya showed reverse magnetisation and hence was apparently more than 0.7 m.y. old. J.D. Bignell and N.J. Snelling (read by Snelling) gave a comprehensive review of the very many radiometric age determinations on Malayan igneous rocks which have been made by them in the past several years. Analysis of K/Ar and Rb/Sr ages reveals a series of major and minor 'events' ranging in age from Carboniferous to early Tertiary, with a small group of Silurian ages best regarded for now as doubtful. Snelling then attempted to fit these ages of igneous activity into a scheme of development for Malaya using the ideas of plate tectonics. Like Hamilton, Snelling interprets the eastern part of Malaya as a bit of continental crust rafted against the western part during Carboniferous, the collision causing a new subduction zone farther east to replace the previously active one at the site of the present Main Range.

During discussion, calls were made for more age determinations. Snelling said that what is needed now is better geologic controls and dates from volcanic rocks rather than more work on the granites. His group would not like to undertake dating of individual ore minerals, as was suggested, since mineral ages (with the exception of galena) often give wild and uninterpretable results. C.S. Hutchison supported Snelling, pointing out that recent work has shown that the Cretaceous granites of Malaya can be distinguished from the older granites by the presence of a high-temperature variety of K-feldspar.

Sections 5 and 6, on Regional Mineralization and Exploration Concepts and Techniques, were merged in the final program to give a large and important session on the mineral deposits of Southeast Asia. Ba Than Haq reviewed the metallogenic provinces of Burma and their relationship to tectonic episodes. A noteworthy conclusion was that the tin mineralisation is associated with Mesozoic - and mainly late Mesozoic - events, a conclusion finding support in work in Thailand and West Malaysia. F.C. Gervasio gave a review of the mineral deposits of the Philippines, where the abundance of copper is remarkable, while A.H.C. Mitchell and M.S. Garson (read by Mitchell) attempted to relate tin, tungsten and fluorite in Southeast Asia to ancient subduction zones, an attempt that aroused considerable discussion and disagreement about the positioning of these former subduction zones.

The rich tin fields of West Malaysia (Malaya) deservedly came in for considerable attention. K.F.G. Hosking gave a comprehensive account of the primary tin mineralization, its geographic distribution in an eastern and western belt, and age relations as far as known. He proposed a scheme of genesis for the tin deposits in line with the ideas of Y.A. Bilibin on the sequence of events in

orogenic zones, modified in the light of plate tectonics. E.B. Yeap then gave a detailed account of the primary mineralization of the Kuala Lumpur tin field, dividing the lodes into genetic types and describing their mineralogy and origin. B.K. Tan discussed the relationship of some West Malaysian tin lodes to structural features, suggesting that the major control may be areas of tension associated with systems of parallel or en echelon wrench faults. M. Tharmarajan showed how sedimentological analysis was able to relate the placer tin deposits of one area near Kuala Lumpur to Pleistocene drainage patterns.

For other areas of Southeast Asia, descriptions were given of scheelite deposits in northern Thailand (W.C. Eberle, presented by F. Baum); and of nickel-bearing laterites in Irian Barat (C.D. Reynolds and others), laterite deposits in southeast Sulawesi (P.T. Int. Nickel Indonesia), and bauxites in West Kalimantan (R. Gunawan and C.V.C. Valk, read by Valk), all in Indonesia.

Papers on mining and exploration methods were presented by S. Sigit, summarizing recent developments in Indonesia, K.J. Henley on the evaluation of beach sands, and A. Hess (presented by F. Baum) on the use of the induced polarization method for prospecting in Thailand.

In a general discussion session ending the section on mineralization, C.S. Hutchison brought up what he felt was the often neglected possibility that primary mineral deposits (in this case the tin of West Malaysia and adjoining areas) were recycled from older concentrations. A.H.G. Mitchell pointed out that this would seem to require the coincidence of the earlier deposits having been located exactly on the arcuate zone that became the later orogene in which they are now found. N.J. Snelling also said he regarded the tin mineralization in Thailand, Malaya, the Tasman Geosyncline and Hercynian Europe as the result of a "once-only" event, possibly a

surge of out-gassing of volatiles. He stated that he felt this was likely because the granites associated with the tin deposits in all these places were unique: highly differentiated, with high volatile content and anomalous Rb/Sr ratios.

K.F.G. Hosking disagreed, saying there were many exceptions to the simple age relations of the granites, and no proof of their genetic, as contrasted to spatial, relationship to the tin. He also felt the association with fluorine was exaggerated, and that really what was more abundant was chlorine, which is high in the fluids of vacuoles in the tin lodes, and which could easily be derived from sea water contained in sediments being dragged down a subduction zone. Hutchison reiterated that the ultimate source of the tin should be the rocks from which the granites were derived, and if so then the high concentration of tin was pre-existing in the region. Hosking agreed with this view.

The degree to which the implications of plate tectonics ideas had penetrated was well shown by this discussion, and while it left major disagreements unresolved many stimulating and possibly fruitful ideas were brought out.

This first Regional Conference on the Geology of Southeast Asia must be considered a great success. For many of the participants it was the first opportunity to discuss regional geology with colleagues from various Southeast Asian countries and from outside the region. Many of the papers presented were not only good but important, and the level of interest among the participants was high. As a result some very rewarding discussions occurred and much was learned. This is after all what such a meeting is for.

Apart from the participants themselves, who of course were the essence, the Regional Conference on the Geology of Southeast Asia was made possible by generous donations from a number of commercial companies, by the University of Malaya's offer of fine facilities, and by the cooperation and assistance of the several United Nations agencies (ECAFE, CGMW and UNESCO), who supported the travel expenses of their delegates. The Conference organized by a hard-working Organizing Committee, headed by D. Taylor, Chairman (and fifth President of the GSM), and with B.K. Tan as Secretary and N.S. Haile as Program Chairman. Other aspects were handled by Sub-Committee Chairmen C.S. Hutchison (excursions), Nik Mohamed (accommodation), and K.F.G. Hosking (reception).

The volume of Abstracts of Papers from the Conference is available from the Geological Society of Malaysia (c/o Department of Geology, University of Malaya, Kuala Lumpur) at M\$6.00 a copy surface postage included. The Society plans to publish some of the papers in full as a volume in its Bulletin series. Based on the success of this regional Conference, the Geological Society of Malaysia will also be tempted to repeat the event after the lapse of a year or two.

Kuala Lumpur

May 1972



(PETER H. STAUFFER)

President

Geological Society of Malaysia