

stratigraphic succession in Malaya does indeed range from at least as early as late Cambrian to as late as early Cretaceous, with very little interruption except possibly in the Devonian and in the Jurassic. The positive identification of Ordovician/Silurian fossils found during the course of the Malaya-Thailand border survey in the predominantly calcareous sequence of the Langkawi Islands<sup>12</sup>, together with the evidence of structural alignment of the underlying arenaceous rocks with those carrying late Cambrian fossils on the Thai island of Terutau, were critical factors in establishing the identity of the older rocks in Malaya. Such positive fossil evidence has not yet been obtained for the predominantly arenaceous beds overlying granite found in the Kelantan (Trengganu) Pahang border areas, but is sufficient to indicate for them late Jurassic or early Cretaceous age. In the current research programme is included a project for determining the ages of the various granite masses by isotope ratios of radioactive elements in constituent minerals such as zircon, and it is hoped that the results obtained will establish some correlation with the sedimentary indications already found.

In view of the considerable extension of the proved time-range of the Malayan sedimentary succession I decided early in 1958 to give to the various rock groups and formations in Malaya definite names according to type localities in accordance with the recommendations of the International Geological Congress Sub-Commission for Stratigraphic Terminology. Table 1 summarizes the newly adopted nomenclature and the comparative classification of Palaeozoic and Mesozoic stratigraphic sequences now established between Malaya and Thailand<sup>13</sup>.

This communication is written as a preliminary announcement to a more detailed paper now being prepared in order to bring up to date the stratigraphic descriptions appearing in the first edition of the section on Malaya in the International Stratigraphic Lexicon. The information in this and the two following communications is published with the authority of the Minister of Natural Resources of the Federation of Malaya.

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### Jurassic/Cretaceous Sediments in Malaya

A FORMATION of gently dipping sedimentary rocks forming the Gunong Gagau plateau was found during a reconnaissance of the Kelantan (Trengganu) Pahang borders in 1952. The succession consists of a coarse basal conglomerate, with cobbles as much as 10 in. in diameter, overlain by a series of progressively finer, interbedded white pebble beds and orthoquartzites, both the latter composed almost entirely of quartz. There are occasional thin red mudstone horizons in which occur plant remains, most of them fragmentary. Recently, better-preserved specimens have been collected which indicate a late Jurassic or early Cretaceous age for the higher part of the formation.

Both in lithology and in the virtual absence of folding and metamorphism these strata appear to be quite unlike any other group of rocks in Malaya, and are the first sedimentary rocks of an age between Trias and Tertiary to have been found. In part they rest with notable unconformity on vertical or steeply dipping interbedded shales, metaquartzites and conglomerates of probable Carboniferous or Permian age. The latter group are characterized by their dark, mainly black, colour arising from the high argillaceous content of the whole succession, and contrast sharply with the light-coloured, overlying beds. Elsewhere, the basal conglomerate overlies granite.

Their discovery throws interesting light on the tectonic history of Malaya. Previously, the folding of sediments and emplacement of granite were thought to be penecontemporaneous and, by analogy with surrounding countries, probably of late Cretaceous or early Tertiary age. However, the present evidence shows that at least a major part of the folding took place early in Jurassic time.

The field-work during the course of which the discoveries were made forms part of the general research programme of the Geological Survey of the Federation of Malaya, and after examination of the area is complete the results will form the subject of a more comprehensive paper.

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### Graptolites recorded from Malaya

GEOLOGICAL investigations within the past few years in the north-western States of the Federation of Malaya have resulted in the discovery in 1956 of graptolites in shale bands interbedded with limestone of Ordovician/Silurian age<sup>1</sup> which outcrop along the north-eastern shore-line sections of the Langkawi Islands (6° 25' N. ; 99° 55' E.). The group of islands lies in the northern funnel of the Straits of Malacca between 20 and 30 miles west of the State of Perlis. Graptolites have been found since in shale associated with limestone in the northern end of the Kinta Valley (4° 46' N. ; 101° 06' E.) of central Perak. Although the graptolites which have been recovered so far are generally of poor preservation they provide sufficient information to date several horizons with considerable accuracy within the period Caradocian-

<sup>1</sup> Scrivenor, J. B., and Willbourn, E. S., *J. Mal. Branch, Roy. Asiatic Soc.*, 1, 338 (1923).

<sup>2</sup> Scrivenor, J. B., "Geology of Malaya" (Macmillan, London, 1931).

<sup>3</sup> Richardson, J. A., Geol. Surv. F.M.S. Mem. 3 (Batu Gajah, 1939).

<sup>4</sup> Fitch, F. H., Geol. Surv. F.M.S. Ann. Rep. 1939, 27 (Batu Gajah, 1940); Geol. Surv. M.U. Ann. Rep. 1946, 49 (Batu Gajah, 1947); Geol. Surv. Fed. Mal. Mem. 6 (Batu Gajah, 1951).

<sup>5</sup> Richardson, J. A., Service, H., and Alexander, J. B., Geol. Surv. F.M.S. Ann. Rep. 1940, 14 (Batu Gajah, 1941).

<sup>6</sup> Richardson, J. A., *Geol. Mag.*, 83, 217 (1946).

<sup>7</sup> Alexander, J. B., Geol. Surv. Fed. Mal. Ann. Rep. 1946, 36 (Batu Gajah, 1947).

<sup>8</sup> Alexander, J. B., Geol. Surv. Fed. Mal. Ann. Rep. 1949, 29 (Batu Gajah, 1950); and unpublished thesis (1951).

<sup>9</sup> Alexander, J. B., "I.C.S. Lexicon", 3, Asia, fascicules 6b and 7c, Malaya, 1954 (Centre National de la Recherche Scientifique, Paris, 1956).

<sup>10</sup> Sresthuputra, V., Buravas, S., and Brown, G. F., Geol. Surv. Mem. 1 (Royal Thai Dept. Mines, Bangkok, 1953).

<sup>11</sup> Alexander, J. B., paper presented at E.C.A.F.E. Conf. Sen. Geol. (Calcutta, 1957).

<sup>12</sup> Jones, C. R., paper presented at Pac. Sci. Congress (Bangkok, 1957).

<sup>13</sup> Sethaput, V., "I.C.S. Lexicon", 3, Asia, fascicule 6c, Thailand (1955) (Centre National de la Recherche Scientifique, Paris, 1956).