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The dynamic evolution of the Palaeozoic geography of eastern Asia

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ABSTRACT

New palaeogeographical reconstructions are presented for eleven time intervals through the Palaeozoic of the eastern Asia region from the Middle Cambrian at 510 Ma to the end of the Permian at 250 Ma. They centre on the continental blocks of North China, South China, and Annamia (Indochina) and their relationships with northeastern Gondwana (which was united to form part of Pangea from the Late Carboniferous onwards). Also shown is the continent of Tarim during the Lower Palaeozoic, as well as the Hutag Uul–Songliao and Khanka–Jiamasu–Bureya terranes, both of which straddle the Russian, Mongolian and Chinese borders today, from Silurian times onwards. We conclude that Annamia and South China were united as a single continent throughout the Lower Palaeozoic and Early Devonian and were translocated by major strike-slip faulting along the northeastern Gondwana margin during that period from off Afghanistan to outboard of the Sibumasu and Australian sectors of the superterrane. They left the Gondwana marginal area together during the Lower Devonian opening of the Palaeotethys Ocean, but very shortly afterwards they themselves divided into the two separate continental blocks that we recognise today, not to reunite until the Triassic. The various Cambrian to Permian rocks found in Japan largely represent active volcanic arcs which originally lay to the southeast of South China, although the Carboniferous was more quiescent there. The Neotethys Ocean opened during the Permian, dividing Sibumasu and the Tibetan terranes from Gondwana, and the Palaeotethys Ocean started to close progressively in the Upper Palaeozoic as most of the East Asian continents and smaller terranes moved towards Siberia. The positions of the various continents and terranes have been deduced from a mixture of palaeomagnetic and faunal data, the positions of Large Igneous Provinces and kimberlites, and the need to provide kinematic continuity between maps of successive ages. However, many uncertainties remain.

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1. Introduction

Eastern Asia is made up of a complex mosaic, most of which were distinct entities of variable ages in the Palaeozoic. To the north of those shown in Fig. 1, at the western rim of the Pacific Ocean southwards from the Bering Straits, there are the Chukhot and adjacent terranes, which were peri-Laurentian and parts of the Chukhot-Arctic Alaska Continent (Cocks and Torsvik, 2011) and the eastern end of peri-Siberia, including the Verkhoyansk–Kolimian Fold Belt (Cocks and Torsvik, 2007). On Fig. 1, to the south of Siberia and peri-Siberia (coloured orange), there is the eastern sector of the Central Asian Orogenic Belt (Junggar, Tarim, Kunlun, Qaidam–Qilian, Ala Shan, Gurvansayhan, Nuhetdavaa, Hutag Uul–Songliao, Sulinheer, Khanka–Jiamusu Bureya, and the Japanese terranes), as well as North China, South China, and Annamia (Indochina). To the south of them lies the northeastern sector of the Gondwana superterrane (which included Sibumasu and East Malaya until the Permian).

That vast area is made up of a large number of geological units which have often been defined and named differently by different authors. Since the advent of the understanding of plate tectonics, many workers have tried to place those units in relation to each other before the Mesozoic; for example, Zonenshain et al. (1990) and Sengor and Natalin (1996) both published pioneer syntheses of Asian tectonics and palaeogeography. The CAOB stretches across Asia from the Urals to the Sea of Okhotsk in the Russian Far East. The belt was first recognised by Suess (1901), and runs between the stable cratons of Gondwana, Baltica and Siberia. All authors agree that Tarim, North China, South China and Annamia represented substantial Palaeozoic continental areas independent of Gondwana, Baltica and Siberia within the eastern Asia region. However, recognition of Sibumasu, East Malaya and the Tibetan terranes as separate entities has varied between authors, but we consider those units to have been integral parts of the margin of core Gondwana (Torsvik and Cocks, 2009, 2011) until the Permian opening of the Neotethys Ocean. In addition, there were also many other smaller geological entities, most of which appear to have originated as oceanic island arcs at various times stretching from the Neoproterozoic to the Permian.

The purpose of this paper is to review the identities and relative positions of the various major regions now in eastern Asia as they developed during the Palaeozoic. Firstly, the continents and terrane units are briefly characterised, and that is followed by a historical summary of each Palaeozoic period together with new palaeogeographical maps.

In Sections 2 to 4 the many units are reviewed in turn, although a few, such as the Gurvansayhan (Section 3.6) and Nuhetdavaa (Section 4.5) terranes of Mongolia are allocated rather arbitrarily within the sections. The easternmost unit, the Nadanhada–Sikhote–Alin Terrane, which borders the Japan Sea (NSA on Fig. 1), consists entirely of Upper Jurassic and later accretionary rocks with substantial Cretaceous granites and thus is not mentioned further here (apart from the Permian brachiopods which are found in blocks within those Jurassic prisms: Section 13). The terminology used varies widely in the literature, but we here use 'terrane' for the smaller units, 'microcontinent' for amalgamated smaller units, 'continent' for the larger units, 'superterrane' for Gondwana and Laurussia, and 'supercontinent' only for Pangea and Rodinia.

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