

3 LATE PALEOZOIC SHELF SEDIMENTS & METAMORPHIC COMPLEXES

3.1 ?CARBONIFEROUS-PERMIAN METASEDIMENTS

3.1.1 The oldest fossiliferous rocks found *in situ* in central and west Kalimantan are located in structural inliers located S and SSE of Kuching and 30 km S of the border and termed the Balaisebut Group (CP) in the Sanggau quadrangle (Fig 3.1). The Group comprises locally carbonaceous slate and phyllite, schist and quartzite and minor limestone, marble and chert. These rocks are ascribed to shelf deposits rather than the IAGMP designation of platform sediments which implies deposition over a much wider area. The metamorphic grade is garnet-greenschist and there are several phases of deformation each with a cleavage. Zeijlmans van Emmichoven (1939), identified Permo-Carboniferous fusulinid faunas as well as Late Triassic faunas but neither has been reconfirmed in the recent mapping. The total thickness is estimated to exceed 1,000m.

3.1.2 The equivalent of the Balaisebut Formation in Sarawak is the less-metamorphosed Terbat Formation (Pimm, 1965), a fusulinid calcareous succession of restricted extent close to the international border. The rocks of the Terbat Formation are mostly recrystallised, dolomitised and silicified, moderately fossiliferous limestones with thin interbeds of highly sheared sericitic shale. The original sediment was composed of a mixture of calcareous mud and fossil debris in a shallow water, shelf environment devoid of terrigenous material. Although some of the fossils are distorted by subsequent

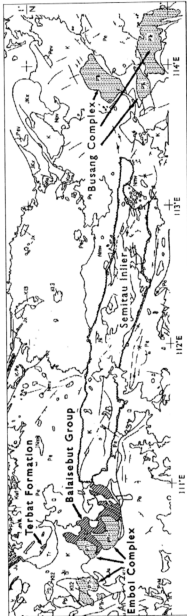


Fig 3.1 Distribution of Carbo-Permian metasedimentary rocks and Perno - Triassic igneous & metamorphic Complexes in Kalimantan and W Sarawak. (after Tan, 1982) & Pieters & Supriatna, 1990)

tectonism, the overall metamorphic grade appears to be much lower than that in the Balaisebut Group. The rocks are generally steeply dipping and the total thickness is of the order of 600m.

3.1.3 There are no faunal comparisons with the Terbat Formation fusulinid assemblages described from Sarawak (Cummings, 1956; 1962) which is dated as Carbo-Permian (Sanderson, 1966), but it seems likely that they could be equivalent although with slightly different age ranges. The paleo-environment of both Formations is largely shallow marine. The differences in metamorphic grade and possibly also structural style between the Balaisebut and Terbat Formations may perhaps be related to the Upper Permian-Middle Triassic orogeny, during which the igneous and volcanic rocks of the Embuoi Complex and Sekadau volcanics were emplaced. The orogeny seems to have had a greater intensity in Kalimantan.

3.1.4 Two major unconformities within the Paleozoic-Lower Mesozoic of Sarawak (Pimm, 1965), pre-Permo-Carboniferous and Upper Permian-Middle Triassic, are thought to exist in the Sanggau area of NW Kalimantan (Supriatna, S. *et al.*, 1989b) but the nature of the unconformities above and below the Balaisebut group is unclear as contacts with the Embuoi Complex are invariably faulted.

3.2 PERMO-TRIASSIC IGNEOUS & METAMORPHIC ROCKS

3.2.1 A number of Permo-Triassic igneous and metamorphic fault-bounded inliers from 10 - 40 km across occur in a latitudinal belt just north of the equator. The Embuoi Complex (PTR) located at the W end of the Semitau inlier forms

part of a Permo-Triassic igneous assemblage in the Sanggau quadrangle (Fig 3.1) and comprises basic volcanics, amphibolites and schists, the latter being possibly mylonitised granitic rocks as there are zones of intense shearing within the Complex (Supriatna, S. *et al.*, 1989a,b). The rocks are strongly foliated. K-Ar dating indicates two separate crystallization events, a primary one 263-230 Ma, Late Permian- Early Triassic, and a secondary recrystallization from 214-201 Ma, Late Triassic-Early Jurassic (Bladon, G.M. *et al.*, 1989). In the east, more acidic igneous and metamorphic rocks are encountered in the Long Pahangai (Abidin & Sudana, 1989) and Putussibau (Pieters, *et al.*, 1988, Surono & Noya, 1989) quadrangles where they are mapped as the Busang Complex comprising foliated granitic rocks together with schists, gneiss and quartzite. K-Ar determinations on granite rocks range from 207-235 Ma. The Busang Complex is fault-bounded against less metamorphosed Cretaceous Selangkai Formation and forms a structural complex of uncertain origin. The Busang-Murung Crescent containing the Busang Complex (Doutch, H.F. *in*: Abidin & Sudana, 1989) and the Kebayan (Embuoi Complex) inliers are positioned at either end of the Semitau inlier (Doutch, H.F. *in*: Abidin & Sudana, 1989) and Trail (pers. comm. Trail to Doutch *in*: Abidin & Sudana, 1989) noted the possibility that they are detached bodies 'floating' within the melange. If so, the bodies are extremely large, being up to 40 km across.

3.2.2 The genetic origin of the rocks forming the Embuoi and Busang Complexes is obscure and in the absence of geochemical data, the structural units are classified as undifferentiated basement. Further petrologic and chemical studies may show that they were originally ultrabasic complexes as in eastern Sabah where mig-

matitic rocks are derived from ophiolite suites by sub-seafloor metamorphism (Hutchinson & Dhonau, 1971). If so, they could be genetically allied with the Late Triassic Serian Volcanics to the North and Sekadau Volcanics further west.

3.2.3 Reconstructions of the Late Paleozoic - early Mesozoic paleogeography based on the sedimentary evidence suggest that NW Kalimantan and W Sarawak were located in tropical waters. The nature of the igneous and metamorphic Complexes suggest possibly an island arc regime within an oceanic plate, continuing the oceanic environment shown by evidence from the Pre-Carboniferous rocks. There is no evidence for a large expanse of continental crust. There is, however, some doubt concerning the values obtained from K-Ar dating which sometimes gives erroneous results mainly due to argon loss. The radiometric ages determined from the Busang and Emboi Complexes may be younger than the real age of the rocks. Further detailed petrographic studies and perhaps a radiometric age using uranium isotopes may provide a more reliable dating of the Complexes.