

### The Singa Formation: is it a glacial deposit?

Peter H. Stauffer, Jabatan Geologi, Universiti Malaya, Kuala Lumpur.

*The Singa Fm. in Langkawi forms most of the clastic interval between conspicuous Lower Paleozoic (Setul Fm.) and Permian (Chuping/Jong Fm.) carbonate sequences. It has intrigued many geologists because it is almost totally barren of body fossils, despite its generally fine-grained and carbonaceous nature, and especially because it contains numerous scattered megaclasts, mostly pebbles but also up to boulder size. "Ice-rafting" and "slumping" have been considered to explain these megaclasts, and previous workers, after considering the former, have opted for the latter (e.g. Gobbett, 1973; Ahmad Jantan, 1973).*

*However, recent compilation of the features of the Singa Fm. and its equivalents in Thailand and Burma (Stauffer and Mantajit, in press) has brought out a pattern of characteristics more consistent with a glacial origin. These characteristics include:*

1. *Great lateral extent of the pebbly carbonaceous mudstone facies (nearly 2000 km) implies relation to widespread rather than local conditions.*
2. *Grain size distribution is commonly seriate, unlike the bimodal or polymodal curves typical for resedimented ("slumped") sediments.*
3. *Abundant fresh feldspar grains, unweathered megaclasts of granitic rocks, and pebbles and cobbles of limestone suggest rapid erosion in a cold climate.*
4. *Clasts of plutonic rock (including boulders up to 1 m diameter) are exotic, as no pre-Carboniferous acid plutons are as yet known in Malaya, south Thailand or Sumatra.*
5. *The general lack of body fossils and the low diversity in the rare faunas found within the pebbly mudstones are consistent with a cold climate.*
6. *Trace fossils in the Singa Fm. include long (over 1 m) vertical burrows strongly suggestive of deposition in very shallow water. These burrows transect intense "slump" folds, making it difficult to suppose the folds related to a major slope; it is possible that they were caused by movement of grounded ice masses.*

*If the pebbly mudstones of the Singa Fm. are glaciogenic sediments, implications for paleogeography and continental drift history are obviously far-reaching. Major changes of climate (from tropical to cold temperate to tropical again) and probable large concomitant changes of latitude are implied for at least part of Southeast Asia during the interval Silurian to Permian. One problem, however, would be solved: the evidence for the*

anomalous paleogeographic interpretation (deep ocean to the west) of Garson, et al. (1975) would be removed if the Phuket diamictites are not deeper water "slumped" sediments.

Where could the ice sheets that fed debris to these sediments have been? From the size of area involved, they were most likely part of the Gondwana glaciation. Maps of Gondwanaland show that glaciation reached the known margin of the landmass in three areas. For two of these, attachment of the Yunnan-Malaya belt would involve unreasonable drift paths. The third, the section Arabia-India, is a possible source area.

\*\*\*\*\*