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Interactive comment on "The Cretaceous and Cenozoic tectonic evolution of Southeast Asia" *by* S. Zahirovic et al.

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Review of the manuscript Âń The Cretaceous and Cenozoic tectonic evolution of Southeast Asia Âż

by S. Zahirovic, M. Seton, and R. D. Müller

Evaluation the overall quality of the discussion paper ("general comments")

This paper is taking a multi-source approach to precise some aspects of the Geodynamics of SE Asia. This kind of paper is difficult and requires to have assimilated a lot of literature; particularly in this case where geology and tomographic data have to be integrated. The methodology is good and the paper is both regional and thematic. It is a very interesting paper although many of conclusions are widely accepted or have

already been proposed. Among the new ones the Philippine Sea Plate originated on the periphery of Tethyan crust is a new one. These propositions have however to take into consideration the considerable amount of geological data collected in this wide region, and this might lead the authors to modify, precise or explain better some of the contradictions, mostly concerning the New Guinea margin during the Late Mesozoic and the age of the Proto South China Sea. I have tried to highlight some of them in order to help the authors. Most of all, the figures are far too complex and very difficult to read. Many of them have to be redrafted or simplified since the computer models may be good on the screen but not on the figures. Providing that these major points are discussed or checked on the basis of the following comments, and the figures simplified, I would be very happy to see this paper published.

scientific questions/issues ("specific comments")

Docking of Argoland. : This issue has been discussed in several papers and together with the evolution of Meratus Mountains. The subduction was probbly toward the north during Cretaceous times according to datings of foraminifers bearing reef limestone included in the Alino volcanic formation (see also Yuwono, 1988, cited). I agree with most of the options chosen for E. Borneo. The Pre-Late Cretaceous obduction ophiolite in Meratus is accompanied by HT Metamorphism. The discussion about the Argo/Burma tripple juction would benefit from the remarkable work of Norwick on the reconstructions of NW shelf of Australia. This is consistent with the synthesis of ages presented in this paper; the age gap between 75/65 (end of subduction in Sumatra/proto Sunda subduction and 45 subduction jump in the Present Sunda trench.

The South China Sea / Proto South China Sea issue P1363, Line 20 and below; the model of opening of the SCS of Shlutter as a back-arc goes against all the geological and geophysical data (there is a tremendous amount of seismic lines, geological datings. . .) and no trace of the volcanic arc. Up to now the subduction of the PSCS is associated with the Southward subduction of the PSCS. Tonkul participated a lot, but the original ideas are much older (Holloway 1982. . .). P1354. The correlation of Semi-

tau with S China is actually commonly admitted and come naturally when you restore the South China Sea and the PSCS openings. The block having docked against the rest of Borneo is probably not a real collision since it was already nearby. It is rather the shortening of crustal marginal blocks of the South margin of the SCS like the Palawan, Miri or Luconia; which are blocks individualized during the rifting.

The New Guinea ophiolites. The proposition of the Jurassic basin connecting to Tethys raises several issues. The rifting along the former margin of New Guinea is indeed during the Triassic (Tipuma formation) and the Sea floor spreading probably too place during the Callovo Oxfordian altough it could be older south of the Bird's Head ; However the geochemical signature of the ophiolite of the Central Range of New Guinea (Irian jaya) is a text-book example of Back-arc basin (see Monnier et al, 1999 ?, and Pubellier, Ali and Monnier, Tectonophysics, 2003). This is true also for the Eocene coastal ophiolite.

Introduction and Plate Model Reconstructions: Although I do not like to push my papers, it would be good to have a look at the first GIS based reconstruction on the sphere (I can send this paper if not accessible). Pubellier, M., F. Ego, N. Chamot-Rooke & C. Rangin (2003), The building of pericratonic mountain ranges: structural and kinematic constraints applied to GIS-based reconstructions of SE Asia, Bull.Soc. géol. Fr., t. 174, n°6, pp. 561-584 Sea also papers from Scotese's group (Paleomap) The extension in the Gulf of California started around 11 Ma in Sonora and Baja if I remember correctly.

Discussion on the sutures The Biliton Depression is supposed to be a suture zone by some authors.It has to be specified if it is similar or reactivating the Lupar line; otherwise it is just the south side of the Natuna Arch; unless new data are presented. Similarly the Figure 3 shows the Boyan Suture (different from the classical Lupar Line?). In the same legend, please precise "It does not cross-cut the older Bentong Raub zone (Fig " The Bentong Raub zone in this region is not known precisely particularly offshore. There is some imprecision or confusion in this section and the legend of figure 5

On Figure 5, there is a weird suture in the middle of the NW Borneo wedge, approximately where the MMU unconformity is known. This area has been documented quite a lot and I have never seen this suture, (although I live in Malaysia).

The Luk-Ulo also known as Karasambung by the Indonesian colleagues is not a straight line between Java and Meratus but a curved line which passes near Bawean Island. This area is very well documented by the industry.

I am a bit surprised by the lack of affinity between Semitau and Indochina during Triassic and Jurassic. I see 2 stars; are there 2 samples?; Is this information reliable enough to consider its implication in the geodynamic context? The East Java/West Sulawesi is usually considered as the Argoland, or Argo, or Sumba block. It would be useful to specify the differences or homogenize the names. Besides I also agree that the core of Borneo was already in place in the Jurassic by similarities between the Malay Peninsula, part of Sumatra and the SW Borneo (Kutching) area.

The Fukien-Reinan Massif usually called by most authors Yenshanian Massif is much wider than represented on the Figure 7. Then the classical issue is do we correlate it also with the Cretaceous granites of Thailand and Peninsular Malaysia? The Massif can also be extended a bit further East as the basement of Schwanner continues under the Barito Basin.

The oroclinal bending issue and the Figure 8 The lineaments of the Sunda Shelf visible on any gravity map were mentioned by Hutchison (2010) and follow Katili (1975) are interpreted in this paper as the result of a rotation and compared to an orocline (e.g. Central Asian Orocline?). This is only an assumption. It is difficult to drag and twist a continental plate. Althought I spent a lot of time trying to figure out how its works, I do not understand the way the rotation is performed in this example; are the lineaments used as small circle for the rotation? Then I agree that the core of Borneo would be more distant to Sumatra but this is not reflected by the geological structures. The reference to the Java sea (which does not have any oceanic crust except the extremity

of the Damar/Flores basin) is not the best in the region; the Celebes Sa Makassar Basin are a better example that may illustrate the rotation of Borneo from Ipresian to Oligocene. Otherwise, the rotation of Borneo must be seen as a result of basins that opened to the north of the Present day NW Borneo. The South China Sea opened as a propagator with "V" pointed to the SW, implying a clockwise rotation of the SE margin of the South China Sea (NW Borneo. If all the convergence to accommodate the opening is taken in the closure of the Proto South China Sea, not much rotation is to be expected in the Java Sea. The rotation of this area would imply a large stretching in the Malay Basin and deformation in the Komodo to Penyu basins; which we do not observe. I think this part is to be explained better with simpler and more convincing figures.

Similarly Figures 9 and 10 may be sexy on the screen but are extremely difficult to visualize and interpret as they are, even in colour. The authors need to find a clearer way to illustrate their points. For example Figure 10 is much better.

Figure 11. Again refer to Norwick.

P1353 Philippines and also Figure 12. I agree with the comments on the accretion of blocks. Encarnacion was certainly not the first one to propose the Proto-Philippine Plate initiation and movement. It dates back from Karig for the mechanism, and later Jolivet et al.. and the geology of the E Philippines is known from MGB books. The rotation was studied by Ali et al. and the origin as a supra-subduction zone (the scenario B of this paper) was proposed early by Pubellier et al. (2003), but in front of Australia (New guinea).

Pubellier, M., Monnier, C., Ali, J., 2003. Cenozoic Plate interaction of the Australia and Philippine Sea Plates: Hit-and-Run tectonics, Tectonophysics, 363, pp. 181-199,

The scenario is strongly supported by the nature of the ophiolite on the Central and the coastal ranges of New Guinea which have a back arc signature. The western side 5Mindoro. . ..) is correct.

Along the same line, p1356. "The PSP cannot be linked with the other continental plates" is true from the Eocene but unknown before.

P1359 line 20; Proto Molocca Plate is not on Figure 13a as stated.

The Figure 13a is very confusing. It is indicated in the legend that they are blocks but the colour represent different things (emerged continent (Australia), foreland basin (New Guinea), sliver plate (S Sumatra, and Eastern Philippines), Fold-and-Thrust Belt (Simao, and Central Java. . .). Figure shows I think too many blocks, many of which are not crustal blocks ; e;g ; Sarawak is composed of the allochtonous accretionary wedge representing the former sediments deposited on the N margin of the proto South China Sea : N and W Sulawesi are the same S-Easternmost margin of Sundaland : eastern and western philippines are not separated by the Philippine fault which is a very recent feature (5my in the N and less than 1 My in the S). Why also separating Australia from the S. New Guinea /Arafura foreland ? Hainan also has the same geology than S. China block.

.Figure 14 is too high and too small to be visible in the paper also. It should be simplified and more explicit.

Conclusions I agree with most of the main options taken it this exhaustive compilation. However, the results are not new, although the discussion is done in depth. The rifting of W Sulawesi/East Java/Mangkalihat is known (Mangkalihat uncertain since it is devoid of basement outcrop: only Miocene and Pliocene carbomates) and has been discussed by many authors but under the name of Argo or Sumba Block and the rifting of the core of Borneo has generally been considered as part of S China before the opening of the SCS and PSCS. The discussions had been however on the correlation between the Java and the Argo block, and to the west with the Woyla and Burma block. P1377. There has never been subduction at the Palawan Trench. This is an old idea from before the studies in SCS and Borneo. This concept was due to the wedge-like deformation which is mostly gravitational collapse. The subduction existed

but slightly to the SE in the Present Sulu sea (Cagayan Ridge and the Borneo wedge). I believe the author know this but the phrasing of L10 (p1377) should be changed to avoid confusion.

Interactive comment on Solid Earth Discuss., 5, 1335, 2013.