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Answer

Reply to the comment on *Was the Indosinian orogeny a Triassic mountain building or a thermotectonic reactivation event?* by A. Carter and P.D. Clift [C. R. Geoscience 340 (2008) 83–93]☆

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The aim of our recent paper was to examine regional evidence to explain the origin of a Triassic thermotectonic event in Vietnam, which has traditionally been referred to as the Indosinian orogeny. Over the years, this name has been adopted to describe almost every form of Triassic deformation event across the region, including southern China. To better understand the Triassic thermotectonic event in Vietnam we considered current evidence from local geology and regional plate tectonics starting with deformation events that relate to Gondwana and its subsequent break-up. In their comment, Cai et al. question a number of aspects of this synthesis starting with our description of deformation in the Palaeozoic. Cai et al. write that we proposed welding between South China and Indochina took place in the Silurian. We are puzzled by this comment since nowhere in our paper do we propose a model for such an event. This is a misrepresentation of our paper. We do however detail evidence from other studies that show 450–400 Ma anatectic granites and overprints are common to both Indochina and South China and that the same types of Galeaspids can be found across both areas. Together, these support some form of contact between Indochina and South China until at least the Early Devonian, but this relates to Gondwana and pre-drift history. To reiterate, we do not propose a plate collision event in the Silurian as Cai et al. have suggested.

Cai et al. suggest a number of reasons against the model of southern China being located above a north-dipping subduction zone during the Late Palaeozoic. The lack of major hiatuses in southern China at this time does not necessarily mean that there was no subduction. Indeed, tectonically-erosive active continental margins are characterized by long-term subsidence and continuous sedimentation, while in an accretionary setting. Similarly, the idea that differently vergent structures preclude a subduction setting demonstrates a general lack of understanding of how strain is accommodated in such settings, as trenchward and landward thrusting is seen commonly in the Andes. The lack of a simple younging trend in Triassic metamorphism and plutonism demonstrates nothing simple concerning setting, as arc migration is dependent on the evolving dip of subducting slab, as well as the changing rates of subduction accretion versus tectonic erosion.

Cai et al. also comment on the presence of Devonian-Triassic mafic and ultramafic rocks across southern China, Hainan and Indochina as evidence that amalgamation between Indochina and South China could only have taken place in the Triassic. Their comment ignores the fact that in our paper we note that the time difference between the Devonian and Triassic does not rule out a later separation between Indochina and South China through ocean opening, i.e. we acknowledge that Triassic collision is possible. Cai et al. refer to published work in China that provides Triassic

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ages for these rocks, but these works pre-date modern robust *in situ* dating techniques that are able to detect multiple overprints. As a result, we remain cautious about the true ages of these rocks. In our paper, we recognise that in Vietnam the basic rock types have yet to be robustly dated and in the conclusion we wrote "*Robust dating is required to unravel successive thermal overprints in order to provide a date for the generation of the ultramafic rocks and serpentinite bodies considered remnants of Palaeotethyan lithosphere. Only then will we have confidence about the significance of the Indosinian event*". Cai et al. seem to have ignored this.

In our paper, we highlighted the differences in timing and styles of deformation in Vietnam from that found across southern China. In Vietnam, Indosinian deformation occurred at ∼240 Ma and is associated with substantial rapid exhumation localised along major structures, whilst Triassic deformation in southern China is regional in nature and associated with granite melts that range from ∼250 to 190 Ma. If the 240 Ma event in Vietnam was caused by collision between Indochina and South China, the adjacent Nanpanjiang basin would be expected to record this event through arrival of course sediments and breaks in sequence. Cai et al. point out that basin sedimentation is largely continuous and they question our interpretation of the basin record. We contend that sediment volumes and palaeocurrents are inconsistent with collision at 240 Ma. Cai et al. do not agree and prefer to interpret the palaeocurrent evidence differently by invoking diachronous collision between Indochina and South China. Their need for diachroneity stems from the fact that the major clastic influx took place in the Late Triassic some 20 million years after the 240 Ma thermotectonic event in Vietnam. In the title, we posed the question "*Was the Indosinian orogeny a Triassic mountain building or a thermotectonic reactivation event*?" If collision between Indochina and South China involved mountain building, the erosional response would effectively be instantaneous because erosion rates broadly scale with mean elevation. Given that the clastic influx in the Nanpanjiang basin described by Cai et al. has a 20 million years lag, this seems unlikely.

In summary, Cai et al. have wrongly misinterpreted our comments and confused our central objective, which is to explain the origin of a 240 Ma event in Vietnam and whether it involved mountain building.