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Structural evolution of the Argentine Precordillera—the Rio San Juan section: Reply

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IN THEIR contribution Milana and Zambrano point out three main objectives which are: (1) the so-called "segmentation of the Precordillera"; (2) the lateral extent of the Cambro-Ordovician carbonates; and (3) the interpretation of an eastern anticlinal structure.

It is a clear fact that many papers exist which describe and/or interpret the Precordillera or parts of it. Many of them—but of course not all—were incorporated in my original article and can be found in the list of references. Hence, it is not necessary to repeat all the references here. With respect to this point and the 'segmentation' of the orogen, to my impression both authors misunderstood the aim of the paper. It was not meant to be a discussion of all the earlier interpretations of stratigraphy and structural evolution.

I cannot see where in my article a new separation of 'subprovinces' was established which could contradict Ortiz & Zambrano's (1981) division or those of other authors (e.g. Baldis & Chebli 1969, Baldis *et al.* 1982, 1990). The case is quite the reverse: the main structural features and the structural development along the transect can support such segmentation, regardless of how relevant it might be. However, it was not the purpose of the paper to discuss the "stratigraphic and structural subprovincialism". With respect to the poorly defined boundary between the so-called Central and Western Precordillera, one change in stratigraphy can be seen between Qda. de los Ratones and Pachaco, where a siltstone sequence with intercalated basic volcanics obviously is part of the western basin deposits (compare p. 646). If one attempts to define a boundary this area could mark one remarkable change in the stratigraphic sequence (see also below).

The stratigraphic chart in the text is a compilation which also includes data from areas adjacent to the Rio San Juan valley (see the figure caption). As an overview it must be schematic otherwise it would confuse the readership.

The lateral extent of the Cambro-Ordovician carbonate platform is described in many articles (e.g. Baldis & Bordonaro 1984, 1985, Bordonaro 1985, 1990, 1992). The western slope area contains blocks and slices of Middle Cambrian limestones, amongst others also of the San Juan Formation. Several papers deal with this slope as a transitional part between a western basin and an eastern carbonate platform (e.g. Bordonaro 1985, 1992, Fernandez *et al.* 1987, Gallardo *et al.* 1988).

In the Pachaco area the San Juan limestone represents the base of a thick thrust sheet with the Silurian to Devonian sequences on top. This is indicated on both the map and profiles of the original paper (figs. 7 and 8). To the west, huge slices of carbonates are part of the slope area. South of km 101.5 of the Rio San Juan valley (Qda. de Los Ratones), the Los Sombreros Formation is exposed. It is described by Bordonaro (1990, p. 24, compare also his figs. 2 and 3) and is also confirmed by observations of our working group. It represents one part of the slope deposits and obviously continues along strike to the occurrence southwest of Pachaco which is described by Banchig & Bordonaro (1990) and Banchig *et al.* (1990).

The lateral extent of the carbonates as a wide platform, which is supported by sedimentological and microfacies studies of our working group, is evident and there is no way to reduce the platform to the deposits of the Ordovician San Juan Formation. It must be noted also that Ortiz & Zambrano (1981) on their profiles depict a thick Cambrian to Ordovician carbonate sequence with a wide extent in the subsurface. Hence, their profiles support the interpretations given in my article, and it remains unclear why Milana and Zambrano now doubt the existence of the widely distributed Cambrian to Ordovician carbonates.

In the profile reconstruction (figs. 3 and 8) as well as in the text all the sub-surface reconstructions and descriptions, respectively, are clearly indicated as interpretations. In their Discussion, the authors possibly did not recognize that these interpretations are also indicated in the figure captions and that unit boundaries and thrust faults towards depth are shown by dot–dash lines.

With respect to the eastern anticlinal structure a few facts must be pointed out. Comparing both fig. 3 of the article, and Milana and Zambrano's sketch map (fig. 1), I cannot see any difference in the overall structure. Nowhere in the article it is stated: (1) that the given interpretation of the anticline is the only possibility; (2) that the W-directed thrust in the Rio Albarracin area (missing on Milana and Zambrano's sketch map) was responsible for the formation of the anticline; and (3) that fault-bend folding was the only mechanism of short-

ening within the thrust sheets. However, from the section across the anticline in the Rio San Juan valley, there is no evidence for an additional E-directed reverse or thrust fault cutting through the sequence.

The small occurrences of the Talacasto Formation at the eastward-dipping limb of the anticline, depicted on Milana and Zambrano's sketch map, indicate that stratigraphically older sediments (Talacasto Formation; Upper Silurian–Lower Devonian) lie on top of the Punta Negra Formation (Middle Devonian) if one postulates that the trace of the anticline axis strikes N–S and lies within the Punta Negra Formation. This would imply an overturned position of the pile of sediments which obviously is not the case.

In their Discussion the authors postulate "an E-verging thrust" to the east of the Talacasto Formation deposits and the entire anticline being a fault-propagation fold. Their structural evidence for such an interpretation is weak, and the following points are relevant.

(1) The occurrences of the Talacasto Formation are everywhere surrounded by Quaternary deposits (which are not explained in the key of Milana and Zambrano's fig. 1). There are no outcrops and thus evidence which could support the position, orientation and the sense of movements of the fault line.

(2) Structural field evidence for the postulated large-scale fault-propagation fold (e.g. trace of the anticline axis, dip and strike of bedding planes) are not given in the text as well as in fig. 1.

(3) Hence it is also possible to postulate an eastward-dipping reverse fault between the Talacasto Formation and the Punta Negra Formation deposits which would fit the overall geometries and could be an appropriate alternative interpretation.

To conclude, the descriptions of Milana and Zambrano are not sufficient to prove a large-scale fault-propagation fold, and they do not give conclusive arguments to discard the anticlinal structure depicted in my article. Furthermore, the data presented there allowed me a substantial view of the structural evolution along the transect, and—contrary to Milana and Zambrano's overview contribution—are supported and documented by sketches, profiles and diagrams which are based on field data.

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