Forum Comment

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A newly identified Gondwanan terrane in the northern Appalachian Mountains: Implications for the Taconic orogeny and closure of the Iapetus Ocean

Stéphane De Souza[1], and Alain Tremblay[2]

[1]Geological Survey of Canada, Centre Géoscientifique de Québec, 490 de la Couronne, Québec, QC, G1K 9A9, Canada

[2]Département des sciences de la Terre et de l'atmosphère, Université du Québec à Montréal, Case Postale 8888, Succursale Centre-Ville, Montréal, QC, H3C 3P8, Canada

On the basis of detrital zircon U-Pb ages, MacDonald et al. (2014) propose a new Gondwanan terrane, the Moretown terrane, which would have been accreted to Laurentia during the Taconic orogeny in the New England Appalachians. This terrane, solely represented by the Moretown Formation, would be bound to the west by the Red Indian Line, the Iapetan suture between Laurentia and Gondwana. We present an alternative interpretation that takes better account of the Neoproterozoic to Ordovician geological history of the Vermont and Quebec Appalachians, where there is no evidence for such a suture.

In northern Vermont, the Moretown Formation is overlain by the Cram Hill Formation, which correlates with the Saint-Daniel Mélange of Quebec (Doolan et al., 1982). The Saint-Daniel Mélange (ca. 465–460 Ma) forms the base of an Ordovician peri-Laurentian synorogenic forearc basin interpreted to be the result of the syn- to late-Taconian exhumation of the orogenic wedge (Tremblay et al., 2011). The Cram Hill Formation also overlies the Umbrella Hill Conglomerate, which unconformably overlies Cambrian Laurentian margin metasandstone of the Stowe Formation (Doolan et al., 1982). It has also been proposed that the Umbrella Hill Conglomerate locally grades upward into the Moretown Formation (Doolan et al., 1982). Based on stratigraphic relationships and petrography, Stanley and Ratcliffe (1985) argued that the Moretown Formation derived in part from the erosion of metamorphosed rift clastics and volcanics exposed in the Green Mountains anticlinorium and was deposited in an Ordovician forearc setting.

The maximum age of the Moretown Formation can be constrained by the youngest dated detrital zircon at 513.8 ± 0.5 Ma (MacDonald et al.), but attributing a minimum age yields ambiguous results due to superposed deformation and metamorphism, especially where the Moretown Formation shares complex relationships with 496 to 462 Ma intrusions and fault-bounded slivers (Ratcliffe et al., 1998). MacDonald et al. propose to use the 502 ± 4 Ma U-Pb age of the Newfane tonalite (Aleinikoff et al., 2011), that they cite as crosscutting the Moretown Formation. However, the dated sample of this tonalite was collected from the Cram Hill Formation, not the Moretown. Nevertheless, the 475.0 ± 0.1 Ma Hallockville Pond Gneiss in Massachusetts seems to clearly intrude the Moretown Formation (MacDonald et al.). On these bases, we prefer to use maximum and minimum ages of ca. 514 and 475 Ma for the deposition of the Moretown Formation, the latter age being possibly as young as ca. 465 Ma if one considers the stratigraphic relationships of northern Vermont. Regarding that the oldest preserved arc-related rocks are dated at ca. 496 Ma in the area (i.e., the Barnard Gneiss; Ratcliffe et al., 1998), the formation of a forearc basin represented in part by the Moretown Formation, could have been initiated as early as late Cambrian–earliest Ordovician. In Vermont and adjacent Quebec, Taconian orogenesis on the Laurentian margin has been attributed to ophiolite obduction, accretion of volcanic arc rocks and nappe emplacement that were initiated at ca. 475–470 Ma (Tremblay et al., 2011; Castonguay et al., 2012).

MacDonald et al. demonstrate that the Moretown Formation shows a dominant Neoproterozoic detrital zircon population between ca. 650 and 520 Ma, with minor peaks at ca. 1050 and 1200 Ma. As a result, they propose an easterly Gondwanan source and that the Moretown Formation must have a different provenance relative to peri-Laurentian clastic rocks, which are dominated by ca. 1000 and 1500 Ma detrital zircons attributed to Grenvillian sources. However, rift-related ca. 615 to 550 Ma volcanic rocks, dikes, and clastic sedimentary rocks are locally prominent along the Laurentian margin, especially along the axis of the Ottawa-Bonnechère graben and the Sutton–Green Mountains anticlinorium (Hodych and Cox, 2007). These Neoproterozoic rocks thus represent alternative sources of detritus that could have been eroded from uplifted Taconian forearc highs and deposited within a forearc basin, in part represented by the Moretown Formation.

Also, MacDonald et al. cite Tucker and Robinson (1990) as attributing to Gondwana the 613 ± 3 Ma gneisses of the Pelham dome, and use this as an argument to better delineate the Red Indian Line. However, Tucker and Robinson (1990) state that distinguishing between a Gondwanan and Laurentian affinity for these rocks is not possible based simply on the presence of Neoproterozoic rocks.

Relocating the Red Indian line to the west of the Moretown Formation is not reconcilable with data from northern Vermont and Quebec, where there is no evidence for such a suture or a subduction polarity reversal during the Late Ordovician, as suggested by MacDonald et al. The detrital zircon record of the Moretown Formation can be alternatively explained by the erosion of Ediacaran Iapetan rift facies during the Taconic orogeny and formation of a peri-Laurentian forearc basin, without requiring Gondwanan contributions.

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