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Stratigraphic evidence from the Appalachian Basin for continuation of the Taconian orogeny into Early Silurian time

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Abstract

Traditional interpretations of the Appalachian Basin during Silurian time suggest a period of tectonic stability between Taconian and Acadian orogenies. However, recent interpretations of evidence from deformation and igneous sources in the northern Appalachians indicate Silurian tectonism centered on and near the St. Lawrence promontory and that this tectonism probably effected sedimentation in parts of the Appalachian Basin during much of Silurian time. Of special interest is the tectonism that extended from latest Ordovician into Early Silurian time and the nature of its relationships with known orogenic events. Although evidence and interpretations from deformation and igneous sources have become increasingly well established, there has been little support from the stratigraphic record. Now, however, criteria based on the implications of flexural models, namely the nature and distribution of unconformities, the presence of flexural stratigraphic sequences, and the distribution in time and space of dark-shale-filled foreland basins, provide stratigraphic evidence from the Appalachian Basin that supports Early Silurian (Medinan; early Llandoverian) tectonism related to Taconian orogeny. In particular, the distribution and local angularity of the Ordovician–Silurian or Cherokee unconformity suggest major tectonic influence and a latest Ordovician to Early Silurian inception for that tectonism. An overlying flexural stratigraphic sequence represented by the Lower Silurian Medina Group and the presence of a dark-shale-filled foreland basin reflected by the Power Glen–lower Cabot Head shales support interpretations of flexural subsidence related to deformational loading. Moreover, the distribution in space and time of the foreland basin containing these shales indicates that the basin is more likely a continuation of the northwestwardly shifting trend of earlier Taconian basins than that of later Salinic basins. Although the kinematic regime may be different from that of earlier Taconian tectophases, the stratigraphic evidence supports a northeastward extension of the Taconian orogeny into present-day eastern Canada during Early Silurian time and illustrates the usefulness of flexure-based stratigraphic interpretations in understanding the timing and extent of some orogenies.

1. Introduction

The Taconian orogeny is widely considered to have been a Middle to Late Ordovician event related to ongoing closure of the Iapetus Ocean. Provenance, position of subduction, and the nature of the colliding crustal blocks are still unresolved and controversial (e.g., Dalla Salda et al., 1992a,b; Dalziel et al., 1994; Pinet and Tremblay, 1995, 1996; Church, 1996; Bock et al., 1996), but it is more than likely that the collision zone was heterogeneous, consisting of small plates, islands and back-arc basins, and that kinematic style and timing of deformation probably varied considerably along the orogen (e.g., Rodgers, 1971; Hiscott, 1984; Drake et al., 1989; Bock et al., 1996; Mac Niocaill et al., 1997; van Staal et al., 1998). Perhaps the only aspects that seemed to bind this tectonic collage into a "single" Taconian orogeny are the progressive northeastward shifting of convergence in time along the Iapetan margin of Laurentia (e.g., Kay and Colbert, 1965; Rodgers, 1970; Bradley, 1989; Pollock, 1989; Ettensohn, 1991; Hibbard, 2000) and the Ordovician age of the events.

However, even the wholly Ordovician age of the Taconian orogeny has increasingly become subject to question. As early as the 1970s, Bird and Dewey (1970) and St. Julien and Hubert (1975), as well as Hatcher (1987, 1989), suggested that Taconian orogeny might have extended into Early Silurian time. Now there is more definite evidence for Early Silurian orogenesis in the form of intrusive activity and deformation that crossed the Ordovician–Silurian boundary in the northern Appalachians (e.g., van Staal, 1987, 1994; Currie and Piasecki, 1989; Bevier and Whalen, 1990;

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Tucker and Robinson, 1990; Doig et al., 1990; Sevigny and Hanson, 1993; Greenough et al., 1993; Pinet and Tremblay, 1995; van Staal and de Roo, 1995; West et al., 1995), in Early Silurian K-bentonites (e.g., Bergström et al., 1997a,b), and in the flexural modeling of large stratigraphic sequences (Quinlan and Beaumont, 1984; Tankard, 1986). New syntheses also support the presence of Silurian orogenesis in the southern and central Appalachians due to northeasterly transpression involving the Carolina Terrane (Hibbard, 2000). Except for the K-bentonites and large-scale stratigraphic modeling, the only other stratigraphic evidence supporting any continuation of Taconian orogenesis into Silurian time is the presence of Lower Silurian, post-orogenic, clastic units like the Shawangunk, Tuscarora, Clinch and their equivalents throughout the Appalachian Basin (Dorsch et al., 1994), but these units are generally interpreted to reflect later sediment influx from tectonic uplands produced by Late Ordovician phases of Taconian orogeny (e.g., Meckel, 1970).

Still, stratigraphic and sedimentologic evidence from the foreland for actual Early Silurian phases of Taconian tectonism was basically unrecognized until the application of smaller scale flexural models adapted by Ettensohn (1991, 1994) from the work of Quinlan and Beaumont (1984), Beaumont et al. (1987, 1988) and Jamieson and Beaumont (1988). The most important aspect of these models is the idea that deformational loading in the orogen produces a cratonward-migrating forebulge and foreland basin (e.g., Beaumont, 1981; Quinlan and Beaumont, 1984), the results of which can be found in the stratigraphic record. Using likely stratigraphic manifestations of these processes, Goodman and Brett (1994) and Ettensohn and Brett (1996a,b, 1998) suggested the likelihood of Early Silurian phases of orogeny based wholly on the disposition and nature of units in the Lower Silurian Medina Group from the northern Appalachian Basin and adjacent parts of the foreland. These basic processes and their stratigraphic manifestations are examined below relative to the formation of an Early Silurian, Taconian foreland basin during Medinan (early Llandoverian) time.

2. Foreland basin formation and stratigraphic manifestations

Growing evidence for Early Silurian convergence and deformation in the northern and southern Appalachians (e.g., van der Pluijm et al., 1993; van Staal, 1994; van Staal and de Roo, 1995; Hepburn et al., 1995; West et al., 1995; van Staal et al., 1998; Hibbard, 2000) suggests the very real possibility of deformational loading and resultant generation of a cratonward foreland basin with an included unconformity-bound, flexural, stratigraphic sequence. According to basic flexural models, as subduction and convergence begin and a deformational load (folds, thrusts, and nappes) accumulates on the continental margin, the lithosphere responds by rapidly generating a compensating foreland basin and peripheral bulge (Beaumont, 1981; Quinlan and Beaumont, 1984) (Fig. 1a). As the load moves cratonward, the basin and uplifted bulge also migrate in the same direction, and erosion on the uplifted bulge generates the bounding unconformity (Fig. 1a), although continental impedance to initial subduction or collision may also be a factor in unconformity development (Dickinson, 1974, p. 22). Most of the loading and concomitant basin-and-bulge migration will progress cratonward, nearly perpendicular to the strike of the orogenic belt, but if the orogeny was diachronous along its length, deformational loading and attendant foreland basins will also shift parallel to the strike of the orogenic belt (Ettensohn, 1987).

The initial result of loading is bulge moveout and uplift of the foreland, which generates a regional unconformity (Quinlan and Beaumont, 1984) (Fig. 1a). The distribution of this unconformity is generally localized to parts of the foreland basin and adjacent craton proximal to the major focus of tectonism and will approximately parallel the strike of the associated orogeny (Ettensohn, 1993, 1994). Moreover, because much Appalachian tectonism was apparently localized near continental promontories, which were subject to greater shortening and resulting deformation (Dewey and Burke, 1974; Dewey and Kidd, 1974; Ettensohn, 1985, 1991), the distribution of unconformities in the Appalachian Basin is commonly asymmetric toward the involved promontories, and not uncommonly, the un-

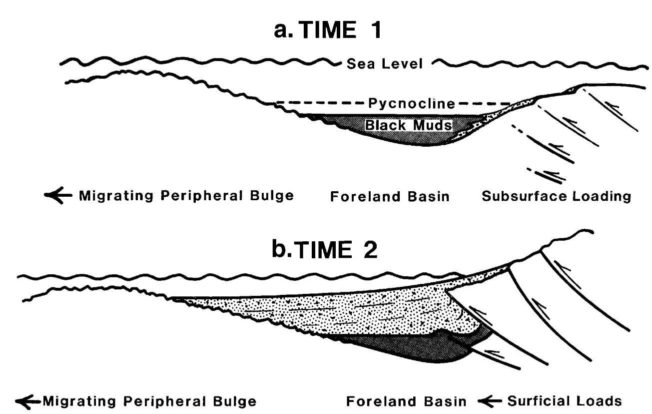

Fig. 1. Schematic diagrams showing hypothesized relationships between the peripheral bulge, unconformity, foreland basin, foreland-basin dark shales and deformational loading: (a) inception of active orogeny; bulge uplift and moveout accompanied by rapidly subsiding foreland basin with transgressive dark shales and a largely subsurface load; (b) later stages of flexural relaxation; subsiding foreland basin infilled with coarser clastic sediments derived from a surficial load. The pycnocline is a zone of thermohaline density gradation accompanying decreasing oxygen content in a stratified water column. Dark stipple: organic-rich, dark muds/shale; large stipple: coarser clastic sediments; wavy lines: unconformities.

conformity also becomes more angular toward the involved promontory (Ettensohn, 1991, 1994). Hence, unconformity distribution in time and space can be an important indication of tectonic influence.

Foreland-basin subsidence, an isostatic response to advancing deformation loads in the orogen, rapidly follows bulge moveout and uplift. Because much of the initial loading is thought to occur in the subsurface and in subaqueous circumstances that generate little subaerial relief (Karner and Watts, 1983), no major source of externally derived sediment is usually available during early phases of orogeny. In the absence of major clastic influx, organic matter from the water column and suspended clays and silt compose most of the sediment in the early basin (Ettensohn, 1992). Inasmuch as the foreland basin is undergoing rapid subsidence with which sedimentation cannot keep pace, the water column soon becomes stratified so that the organic matter is quickly preserved as dark shale in resulting dysoxic or anoxic environments (Fig. 1(a)). Accordingly, the bulge-induced unconformity is typically overlain by dark shales, although a transgressive carbonate, clastic or condensed succession may intervene.

Dark-shale deposition will predominate in main parts of the foreland basin as long as major deformational loading continues, but once thrust propagation declines, the deformational load becomes more or less static, and tectonic relaxation ensues. By this time, however, substantial relief has been generated by emplacement of a surface load (fold-thrust belt above sea level; Fig. 1b), and surface drainage nets have had adequate time to develop. As a result, coarser clastic debris is eroded and transported into the foreland basin as deeper water deltaic deposits, turbidites, contourites, debris flows and near-shore clastic sediments reworked by storms (Fig. 1b). Subsequent lowering of upland source areas and infilling of the foreland basin may be followed by another phase of relaxation resulting in regional rebound and an accompanying wedge of marginal-marine clastic sediments, commonly with redbeds, that appears to overflow from the foreland basin. The net result is an unconformity-bound sequence of dark shales and overlying, coarser clastic sediments (Fig. 2). Such sequences have been called flexural foreland-basin sequences and have been suggested to be indicators of tectonic influence (Ettensohn, 1985, 1991, 1994; Brett et al., 1990a,b; Goodman and Brett, 1994). These sequences are always better developed in parts of the foreland basin proximal to the locus of major convergence. In more distal parts of the foreland basin, however, the resulting sequences are typically more poorly developed or incomplete. More detail on the nature and origin of flexural sequences can be found in Ettensohn (1991, 1994).

Commonly, such sequences repeat several times in a foreland-basin succession (Fig. 2), and each can be

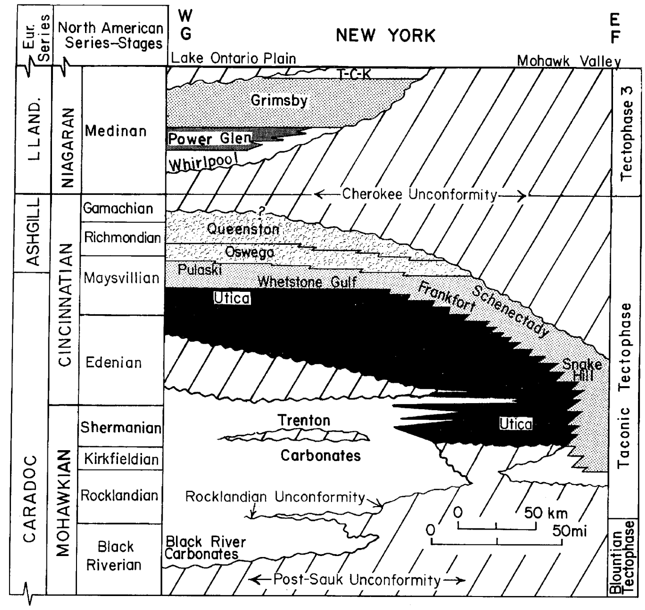

Fig. 2. Schematic west-east section in New York nearly perpendicular to the strike of the Appalachian Basin (line G–F in Fig. 3) showing the nature and disposition of three probable Taconian flexural sequences in the northern Appalachian Basin. Black River carbonates represent the Blountian tectophase but never developed into a typical flexural sequence because of distance from the southerly locus (Virginia promontory) of the tectophase. The Utica and overlying clastics represent a more typical, proximal flexural sequence showing the common cratonward migration of facies in time. The Medina Group appears to represent an incomplete, third flexural sequence. Note the unconformities that bound the flexural sequences and the relative westward migration of foreland-basin sequences and dark shales between Utica and Power Glen times (compare with Fig. 3). Symbols: Black color = dark shales; light stipple = flysch-like clastics; coarse stipple = peritidal and marginal-marine clastics; no pattern = shallow-marine carbonates or clastics; wavy line = unconformity; diagonal lines = missing section; and T–C–K = Thorold, Cambria, and Kodak formations. No vertical scale intended (adapted from Ettensohn, 1991, 1994).

shown to correspond approximately to the duration of a known phase of orogeny (Johnson, 1971; Ettensohn, 1985, 1991, 1994), inasmuch as orogenies progress in pulses or tectophases on the order of five million years or less in duration (Jamieson and Beaumont, 1988). Every repetition or cycle, however, may not exhibit the complete sequence of lithologies, because of location in distal parts of the basin, because a new tectophase may begin before the sedimentary expression of the previous one is complete, or because erosion accompanying new bulge uplift and moveout destroys parts of the previous sedimentary expression. Nonetheless, one consistent feature of these cycles is that the foreland basin and flexural sedimentary sequence generated by each successive tectophase cycle migrates farther cratonward than the previous one, reflecting the continued cratonward movement of deformation (Ettensohn, 1991, 1994); concomitant movement of successive sequences parallel to the strike of the orogen, similarly indicates oblique convergence or transpression (Ettensohn, 1987).

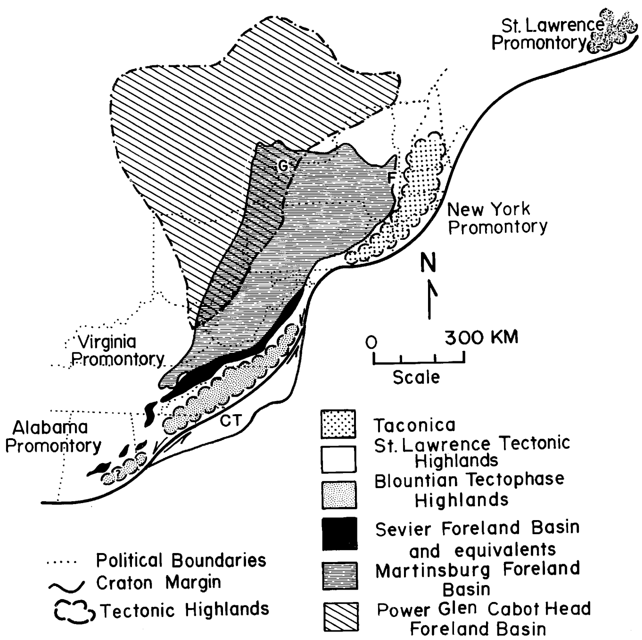

Fig. 3. Schematic map of the Appalachian Basin area showing general positions of Taconian tectonic highlands and dark-shale foreland basins relative to continental promontories during Middle Ordovician to Early Silurian time. Note the general northwestward shift of dark-shale foreland basins in time and the asymmetry of basins toward continental promontories. The Power Glen–Cabot Head basin represents the time of greatest deformational loading and coeval subsidence during the Early Silurian Taconian tectophase; the basin is asymmetrical toward the St. Lawrence promontory, the likely focus of this tectophase. Transpression involving the Carolina terrane (CT) was apparently coeval in the central and southern Appalachians (adapted from Ettensohn, 1991, 1994).

This cratonward movement of flexural sequences is best illustrated by mapping the distribution of the basal dark-shale units (Fig. 3), because the dark shales are easily identified in the surface and subsurface, are more likely to be preserved as earliest parts of the sequence, and probably represent the time of most active tectonism and subsidence. Accordingly, these shales are thickest and best developed behind the promontory at which convergence is concentrated, and the distribution of the shales will commonly be asymmetric toward that promontory. Hence, in following parts of our discussion, we will emphasize the timing and distribution of respective dark-shale foreland basins because they seem to reflect overall patterns of regional tectonism.

3. Stratigraphic evidence for patterns of Taconian tectonism from the Appalachian Basin

3.1. Ordovician foreland basins

Although subduction had probably been active on the Laurentian margin since Late Cambrian time (e.g., Hatcher, 1987; Pollock, 1989), not until the Early-Middle Ordovician transition is there as substantial evidence for collision or docking of a deformational load against the platform margin of Laurentia. In the Appalachian Basin, the initial evidence is in the form of a major regional unconformity variously called the post-Sauk unconformity (Sloss, 1963) (Fig. 2), the Owl Creek discontinuity (Wheeler, 1963), unconformity C (Rodgers, 1971), the sub-Tippecanoe unconformity (Sloss, 1988), the Sauk-Tippecanoe unconformity, or the St. George unconformity (Knight et al., 1991), presumably caused by bulge moveout and uplift (Jacobi, 1981). The associated flexural sequence and basinal dark-shale deposits are largely restricted to the Sevier foreland basin and remnants to the south, indicating that this phase of orogeny was largely active at the Virginia and Alabama (?) promontories (Fig. 3). This orogenic event was called the Blountian disturbance by Kay (1942) and the Blountian phase of the Taconic orogeny by Rodgers (1953). Here, we follow in the tradition of Kay (1969) by including all Ordovician and Early Silurian deformation along the Laurentian margin within the *Taconian* orogeny, and the earliest (Middle Ordovician) flexural sequence is interpreted to reflect the Blountian tectophase of the Taconian orogeny. In northern parts of the Appalachian Basin, distal from the locus of Blountian convergence, this tectophase is represented by the unconformity-bound Black River carbonates (Fig. 2).

The Blountian flexural sequence is succeeded throughout most of its distribution by a second Middle–Upper Ordovician flexural sequence, bound locally by a Middle Ordovician (Rocklandian) unconformity (Fig. 2). Mapping the distribution of this second sequence in time and space shows that the sequence and its basinal dark shales (Martinsburg basin) migrated farther cratonward and northeastward along the Laurentian margin (Fig. 3) while becoming younger toward the New York promontory, where it is best developed (e.g., Fisher, 1977). The timing of sequence development and the asymmetry of the Martinsburg dark-shale basin toward the New York promontory (Fig. 3) indicate that they are products of the Taconic tectophase (Kay, 1937), which was particularly active near the New York promontory (Rodgers, 1971) during Middle–Late Ordovician time. The progressive northwestward migration of flexural sequences and dark-shale basins in time (Fig. 3) supports the diachronous nature of Taconian orogeny indicated through other lines of evidence (Kay and Colbert, 1965; Rodgers, 1970; Bradley, 1989), as well as the importance of continental promontories in localizing successive Taconian tectophases (Kay and Colbert, 1965).

3.2. Early Silurian foreland basin

The Upper Ordovician Taconic flexural sequence ends with another major regional unconformity at the Ordovician–Silurian boundary (Fig. 2) called the Cherokee (Dennison and Head, 1975), Hirnantian (e.g., Brett et al., 1990a), or Tuscarora (Dorsch and Driese, 1995) unconformity. This unconformity is commonly attributed to a glacio-eustatic drawdown that is purportedly supported by worldwide sedimentologic and stratigraphic evidence (Dennison, 1976; McKerrow, 1979), as well as by evidence of coeval Gondwanan glaciation (e.g., Hambrey, 1985; Grahn and Caputo, 1992; Buggisch and Astini, 1993), although more recent evidence indicates that Ordovician phases of this Gondwanan glaciation ceased well before the end of Ordovician time (e.g., Caputo, 1998). However, in the Appalachian Basin, the distribution of the unconformity shows three eastward-projecting salients that correspond to continental promontories (Ettensohn, 1994, Fig. 9), and a pattern of increasing northward erosional truncation and deformation toward the New York promontory that indicates the presence of a tectonic component as well (Ettensohn, 1994; Ettensohn and Brett, 1998). In fact, in parts of the basin inland from the New York promontory, the unconformity is a regional angular unconformity (Brett et al., 1990b; Brett and Goodman, 1996), becoming a very pronounced angular unconformity in the most proximal parts of the preserved foreland basin (Rodgers, 1971; Liebling and Scherp, 1982). Overall, the geometry and magnitude of the lacuna on the unconformity are difficult to explain by eustatic changes alone, necessitating substantial tectonic influence (Middleton et al., 1987; Brett et al., 1990a,b, 1996; Goodman and Brett, 1994; Brett and Goodman, 1996).

Overlying this unconformity, moreover, is a partial flexural sequence represented by the Medina Group (Fig. 2). The Whirlpool Sandstone is its basal unit and represents a nonmarine to marine transgressive sandstone (Middleton et al., 1987; Rutka et al., 1991; Brett and Goodman, 1996) that grades upward into dark shales and storm-generated sandstones in the Power Glen and lower Cabot Head formations. These dark-shale units represent a time of maximum subsidence and marine flooding in offshore, dysaerobic to aerobic environments (Duke and Fawcett, 1987; Duke et al., 1991), although at the margins of the dark-shale basin these shales grade into carbonates or red shales reflecting shallow-marine or marginal-marine transitional environments. The dark shales generally grade upward through tempestite sandstones into shallow-marine and marginal-marine sandstones, shales and carbonates in overlying parts of the Medina and Lower and Middle Clinton groups and their equivalents (e.g., Rickard, 1975; Brett et al., 1990a,b, 1998). Although these overlying units appear to represent a succeeding period of tectonic relaxation (Goodman and Brett, 1994), the succession is unusually complex as it is broken by several small unconformities that may represent superimposed eustatic fluctuations and/or reactivation of local structures.

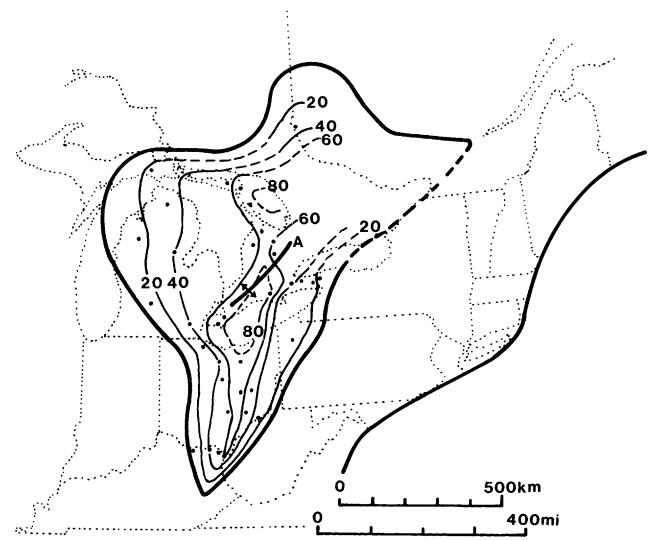

Fig. 4. Generalized isopachous map of the Power Glen–lower Cabot Head shales and their equivalents in south-central Canada and east-central US. Note that the axis of thickening or basin depocenter is close to the present-day axis of the Algonquin Arch. Basin outline largely from Sanford, 1993 (Fig. 11.22). Data points from Williams (1919), Bolton (1957), Horvath (1964, 1967), Poole et al. (1968), Patchen et al. (1985), Shaver (1985), Lukasik (1988), and Brett et al. (1990a). Contour interval = 20 ft.; A = Algonquin Arch.

The distribution of the Power Glen–lower Cabot Head dark-shale basin (Sanford, 1993, Fig. 11.22) is especially interesting because it appears to represent a continuation in the trend of northwestwardly migrating Taconian foreland basins (Fig. 3). Moreover, although preservation is incomplete in extreme northeastern parts of the basin (Fig. 4), the shales apparently had a distribution that was asymmetric toward the St. Lawrence promontory, the promontory at which most of the likely Early Silurian Taconian deformation was concentrated (van der Pluijm et al., 1993; van Staal, 1994; van Staal and de Roo, 1995; van Staal et al., 1998). Hence, the nature and distribution of the Cherokee unconformity, the presence of a partial flexural sequence, and the distribution of the dark shales in that sequence all support the presence of an Early Silurian phase of Taconian orogeny originally identified on the basis of other criteria.

4. Discussion and conclusions

If the timing of unconformity formation is assumed to represent the beginning of bulge moveout and uplift as indicated in basic flexural models – and hence the inception of tectonism – then the latest Ordovician to earliest Silurian age of the Cherokee unconformity is in close agreement with the age of subduction and deformation recently interpreted from other evidence at the St. Lawrence promontory in Canada and nearby areas of New England (van Staal, 1994; van Staal and de Roo, 1995; West et al., 1995; van Staal et al., 1998). Although Silurian rebound following Late Ordovician deformation could explain the nature and distribution of proximal parts of the Cherokee unconformity, the pattern of subsidence and continuation of earlier Taconian trends reflected in the Power Glen–lower Cabot Head dark-shale basin (Figs. 3 and 4) are best explained by a separate, latest Ordovician to Early Silurian phase of Taconian orogeny. In addition, the deepening represented by these shales is too early in the Silurian to represent any known Early Silurian eustatic sea-level highstand (Brett et al., 1998). Assuming that the shales represent the time of maximum deformational loading, the climax of this tectophase occurred in early Llandoverian (mid-Rhuddanian) time based on age assignments of the strata by Berry and Boucot (1970) and Rickard (1975). However, the presence of bentonites of Aeronian age in both the southern and northern Appalachians (Bergström et al., 1997a,b) suggests that this phase of Taconian orogeny must have persisted even longer into mid-Llandoverian time.

This late Taconian event, however, was apparently not the only Llandoverian tectonic event to influence parts of the Appalachian Basin. The Lower Silurian (uppermost Llandoverian, Telychian), Upper Clinton stratigraphic record exhibits another regional angular unconformity and an overlying flexural sequence with mappable dark shales (Williamson-Willowvale shales), and this upper Llandoverian sequence is truncated by yet another unconformity with an overlying flexural sequence containing dark shales (Rochester Shale) that extends from Middle Silurian (Wenlockian) to almost the end of Silurian time (Goodman and Brett, 1994; Ettensohn, 1994). These two later Silurian flexural sequences have been interpreted to represent tectophases of the Salinic disturbance (Goodman and Brett, 1994; Ettensohn, 1994), a more southerly equivalent of Scandian convergence along the Caledonian suture to the north. In contrast to the progressive northwestward shift of Taconian basins (Figs. 3 and 5), the two Salinic basins exhibit a southwestward shift in time (Fig. 5), confirming the idea that the Power Glen–lower Cabot Head basin is the product of deformational loading more clearly related to Taconian than to Salinic orogeny.

Judging by the trend of the thickest Power Glen–lower Cabot Head shales, the depocenter, and presumably deepest water parts of the basin, nearly coincide with the present trace of the Algonquin Arch (Fig. 4), a fact already noted by Dunbar (1960, Fig. 125). This can only mean that the Algonquin Arch was not present during Power Glen time, and that the locus of Taconian subsidence had moved far enough westward so that western parts of the Appalachian Basin and the present-day Michigan Basin area had merged as parts of a single, large foreland basin. By the beginning of the Salinic disturbance in late Llandoverian time, however, the site

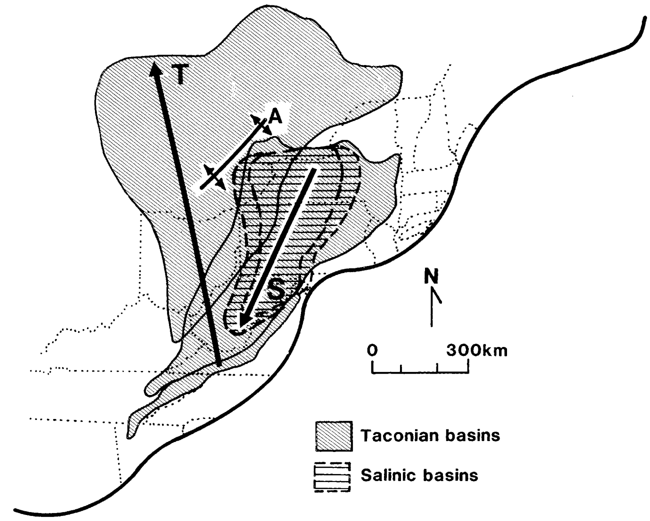

Fig. 5. Schematic diagram comparing the positions and regional migration directions of Taconian and Salinic (Williamson-Willowvale and Rochester) dark-shale foreland basins relative to Iapetan margin of southern Laurentia. T = axis of Taconian basin migration; S = axis of Salinic basin migration; A = Algonquin Arch.

of the Algonquin Arch or its precursor, which had previously been a depocenter in the Power Glen–lower Cabot Head basin, experienced net uplift and erosion, and the new locus of subsidence and foreland-basin deposition moved eastward with development of the Williamson-Willowvale-Upper Rose Hill foreland basin (Brett et al., 1990a,b; Goodman and Brett, 1994) (Fig. 5). From this point in time, uplift of the Algonquin Arch effectively defined the northwestern margin of the Salinic basins, suggesting that its uplift was at least in part a response to Salinic flexure (Brett et al., 1990a,b; Goodman and Brett, 1994). Again, the nature and timing of uplift on the Algonquin Arch relative to the above basins clearly illustrates the fact that the Power Glen–lower Cabot Head and Salinic basins were products of two different tectonic regimes.

The distribution of the Power Glen–lower Cabot head dark shales and in northwestern New York, southeastern Ontario and Michigan, as well of their equivalents elsewhere, reflects yet another dark-shale basin displaced farther northwestward relative to older Taconian foreland-basin sequences. The displacement, of course, reflects the continued northwestward migration of deformational loading during each successive tectophase. However, the increased breadth (Fig. 3) and apparently decreasing depth of each successive basin, based on included sedimentary structures, predominant colors, degree of fissility and fossil content of successive dark shales, probably reflect the increased age and rigidity of the lithosphere toward the northwest and/or the likelihood of more predominantly surficial loads in the later tectophases (e.g., Karner and Watts, 1983).

The Power Glen–lower Cabot Head shales are part of the Lower Silurian Medina Group and with other units in the group form a largely typical foreland-basin flexural sequence bounded by unconformities (Fig. 2). If these dark shales are not in some way part of a foreland-basin sequence, then their temporal and geographic position is indeed anomalous. Moreover, the underlying Ordovician–Silurian or Cherokee unconformity has long been ascribed to a Late Ordovician–Early Silurian glacio-eustatic lowstand, but this cannot be the complete explanation because the unconformity is locally and regionally angular. Although this unconformity may also reflect a component of Late Ordovician–Early Silurian rebound accompanying erosion of earlier Taconian highlands, its association with a likely Medinan foreland-basin sequence may also indicate flexural influence from Early Silurian tectonism deciphered in the area of the St. Lawrence promontory. In fact, recent evidence from igneous, structural and tectonic sources in southeastern Canada and adjacent parts of New England supports the presence of a latest Ordovician–Early Silurian phase of tectonism that apparently represents a northeastward continuation of Taconian orogeny, though not necessarily of the same kinematic style as earlier Taconian phases. The age of the Medinan flexural sequence coincides with the timing of this recently interpreted tectonic event, and the continued northwestward trend of foreland-basin migration reflected in the Power Glen–lower Cabot Head basin is more suggestive of a continuation of Taconian trends than it is of later southwestward Salinic trends. Hence, the concept of a wholly Ordovician Taconian orogeny may be inaccurate, and the above assembly of stratigraphic evidence provides additional support for a northward continuation of the Taconian orogeny during Early Silurian time.

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