Title of article: Flexural extension of the upper continental crust in collisional foredeeps

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SUPPLEMENTAL DATA 0000

To accompany:


APPENDIX: DESCRIPTIONS OF NORMAL FAULTS IN THE MOHAWK VALLEY

The following descriptions and figures (Figs. 16 and 17) provide additional details about the normal faults in the Mohawk Valley, and were excluded from the main manuscript for brevity.

The first major normal fault to the west of the Taconic thrust front is the Saratoga-McGregor fault system, which has been traced about 85 km along strike. Near its southern terminus near section X-X’, the fault downdrops Schenectady Formation on the east against Utica Shale on the west (Fisher and others, 1970). Deeper structural levels are exposed to the north, where Utica Shale on the east is downdropped against Grenville basement quartzites on the west. Displacement increases from south to north from about 137 m at Saratoga (Cushing and Ruedemann, 1914) to about 730 m near Glens Falls (Geragthy and Isachsen, 1981); the fault is marked by a prominent scarp that ranges from 100 to 355 m high from south to north (Geragthy and Isachsen, 1981). Bosworth and Putman (1986) described the only known exposure of the fault zone at Kings Station (locality no. 2 in Fig. 3). Here the fault juxtaposes Grenville basement quartzites on the west against downdropped Beekmantown Group dolostones on the east. The fault zone is about 300 m wide and consists of blocks of Grenville and Beekmantown (up to 50 m long), in a matrix of breccia of the same protoliths. Although the overall attitude of the fault zone is unknown, minor faults in the adjacent basement strike about 010° and dip 70° E; this may be representative of the main fault as well. Similarly, the Rock City Falls fault, a minor westerly splay of the Saratoga-McGregor fault, dips 65° E at locality no. 3. The age of motion on the Saratoga-McGregor fault system has been subject to much speculation. Bosworth and Putman (1986) showed that some Grenville basement quartzites within the fault zone first experienced ductile mylonitization at >12 km depths, prior to brecciation. They suggested that the fault may have originated during Late Precambrian and was reactivated later, such that initially deep fault rocks were eventually brought up to the surface. If so, most of this early displacement would have preceded deposition of the Paleozoic strata, since the maximum offset on the sub-Cambrian unconformity is but 730 m. The disappearance of the fault within the Schenectady Formation just south of the line of section X-X’ suggests to us that some motion was coeval with Ordovician foredeep sedimentation. Several lines of evidence suggest that the northern part of the Saratoga-McGregor fault also has been active during Neogene time, as the southeastern bounding fault of the still rising Adirondack dome (for example, Geraghy and Isachsen, 1981): (1) the fault is marked by a sharp, prominent scarp that increases in height northwards, in keeping with an increase in displacement. (2) easily erodable Utica Shale occurs on the escarpment face, suggesting that the scarp has not retreated significantly since it formed; and (3) carbonated springs issue from the fault at Saratoga; such springs are unique in the northern Appalachians.

The next major normal fault to the west is the Hoffman’s fault, which also downdrops toward the orogen. Along section X-X’, it juxtaposes the Beekmantown Group against Schenectady Formation; estimated throw is 381 m near the Mohawk River. Farther north, it divides into the Galway Lake fault and two other unnamed strands, which form a graben of Cambrian strata between bounding blocks of Grenville basement. Two
lines of evidence suggest Ordovician motion (Fig.4): (1) The Hoffmans fault dies out southward at about the Utica-Schenectady contact, and clearly does not cut the post-Ordovician unconformity. The displacement decreases from nearly 400 m near locality no. 4, to zero about 10 km to the south, as mapped by Fisher (1980). This suggests that the fault was moving during deposition of the Utica Shale but not the Schenectady Formation. (2) The Hoffmans is one of several faults in the Mohawk Valley that are flanked by conglomeratic horizons within the Black River and (or) Trenton Group. On the upthrown block just west of the Hoffmans fault (locality no. 4; Fig. 4), the limestone-matrix conglomerates within the Amsterdam Limestone (Black River Group) contain clasts of the underlying Beekmantown Group (Fisher, 1980, p. 18). Similar conglomeratic horizons also occur in the overlying Larrabee Member of the Glens Falls Limestone (lower Trenton Group) at localities no. 4 and 5; clasts in these younger conglomerates were derived from both the Black River and Beekmantown Groups. The localized occurrence of conglomerates near the fault, and their lateral gradation into nonconglomeratic limestones at Manny Corners just 6 km across strike to the west (locality no. 6; Park and Fisher, 1969), suggests they were shed from an uplifted fault block that had risen above previously smooth carbonate platform (Bradley and Kusky, 1986, p. 675).

Continuing west along section X-X', the next major fault is the Noses fault. It also downdrops to the east, juxtaposing Grenville basement against Utica Shale at the section line. To the north, the Noses fault is probably truncated by the relatively minor Fultonville fault as shown in Figure 3 (after Fisher, 1980); farther north, the large displacement on the Noses fault is taken up on the NE-striking East Stone Arabia fault. The latter fault system continues many tens of kilometers to the NE to Sacandaga Reservoir (Fig. 16), the site of a graben of Cambrian and Ordovician strata, flanked east and west by Grenville basement. Conglomerates in the downdropped lower Trenton Group just east of the Noses fault (Van Wie Creek, locality no. 7; Fig. 4) contain clasts of Potsdam-type sandstone and Beekmantown-type dolostone (Cisne and others, 1982, p. 235). Cisne and others (1982) suggested that the conglomerates were derived from the upthrown footwall of the Noses fault, where Utica Shale directly overlies Beekmantown Group, and the Trenton Group is absent. South of section X-X', the Trenton Group reappears on the downdropped west side of the antithetic Sprakers fault. At locality no. 8 (Flat Creek), the Trenton Group includes boulder conglomerates derived from Beekmantown Group dolostones (Kay, 1937, p. 264); however, at locality no. 9 (Canajoharie Gorge), 5 km across strike to the west, conglomerates are not present in the Trenton Group. These observations together suggest that the Noses and Sprakers faults bounded a horst during deposition of the Trenton Group (Fig. 4).

Extending west about 40 km from the Noses fault along section X-X' is a belt of synthetic and antithetic normal faults spaced a few km apart, which together define several grabens and half grabens; displacements along section X-X' are given in parentheses. The most prominent feature in this region is a graben of Utica Shale is bounded on the west by the synthetic Mother Creek fault (137 m), and on the east by the antithetic Ephratah (at least 162 m) and West Stone Arabia (146 m) faults. These faults can be traced many tens of kilometers northward into the Adirondack Mountains, but die out to the south in the lower part of the Utica Shale. Farther west is another complex graben bounded on the west by the synthetic Manheim fault (40 m); immediately to the east are a series of antithetic step-faults, the Crum Creek (61 m), Timmerman Creek (40 m), and Kringsbrush (37 m) faults. These faults also die out southward in the lower half of the Utica Shale; one minor fault, the Caroga Creek, also appears to die out northward within the Utica. In moderately dipping Dolgeville facies of Fisher (1977) downdropped next to the Manheim fault at locality no. 10, a small, recumbent, stratabound fold pair may record synsedimentary tilting of the host strata (Fig. 7a). On the upthrown block between the Manheim and Dolgeville faults at locality no. 11 (Inghams Mills) is an occurrence of cobble conglomerate in the
Kings Falls Limestone in the lower part of the Trenton Group (Fig. 8b). Set in a matrix of bioclastic limestone are clasts of Beekmantown Group and Grenville metasedimentary rocks. If the clasts were derived from a nearby fault scarp, the most likely place is from the upthrown western side of the Little Falls fault, about 5-6 km across strike to the west, where basement rocks are locally exposed today.

High angle faults west of the Little Falls fault mostly have smaller displacements, shorter strike lengths, and more northeasterly strikes than the main north striking faults to the east. Minor normal faults cut Caradocian carbonate rocks as far west as 222 km from the thrust front. The largest and most noteworthy structure in this region is the Prospect fault. At Trenton Falls (locality no. 14), the fault strikes dips 57° SE, downdropping upper Trenton Group (northwest of the fault) 58 m with respect to lower Trenton Group (southeast of the fault). Here the fault is mapped as a reverse fault (Miller, 1909). Strata in the hangingwall are sharply upturned next to the fault (maximum bedding dip is 46°), as is true of so many normal faults in the Mohawk Valley, but the sense of drag is consistent with normal rather than reverse displacement. These observations could be explained if the Prospect fault had an early history of normal slip, followed by reverse slip sometime later. The fault also reverses its sense of slip along strike in a manner characteristic of wrench faults; downthrown strata lie northwest of the fault at locality no. 14 (Fig. 3), but southeast of the fault a few kilometers along strike to the northeast. Two slump horizons have been recognized in the Trenton Limestone at locality no. 14 (Fig. 4). Their presence suggests syn-Trenton tilting of the sea floor, perhaps a consequence of motion on the Prospect fault. To the southwest, the Prospect faults dies out within the Utica Shale and does not cut Silurian strata.
Fig. 16. Map of the area of Figure 3 showing place names. Numbers 1-14 are localities mentioned in text.

Fig. 17. (a) Lower hemisphere equal area projection showing poles to major and minor normal faults seen in outcrop in the Mohawk Valley. (b) Area-proportional rose diagram showing strikes of major normal faults along the line of section X-X' in Figure 6. Stippled petals represent faults east of the Herkimer fault; unshaded petals represent faults from the Herkimer fault westward. The eastern population of normal faults is roughly parallel with mean strike in the thrust belt (Bosworth and Vollmer, 1981), and is approximately perpendicular to the mean slope of the foredeep as revealed by oriented graptolites in the Utica Shale (Cisne and others, 1982).