The Formation of a Foreland Dipping Duplex at Eagle Rock Gap, Virginia

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Introduction

Complexly folded and faulted Ordovician and Silurian clastic rocks are exposed in two roadcuts through Eagle Rock Gap, Virginia. Eagle Rock Gap, a watergap cut by the James River, is located within the Eagle Rock Quadrangle (Fig. 1) on the northwest margin of the Great Valley of Virginia. The exposures mapped in this study

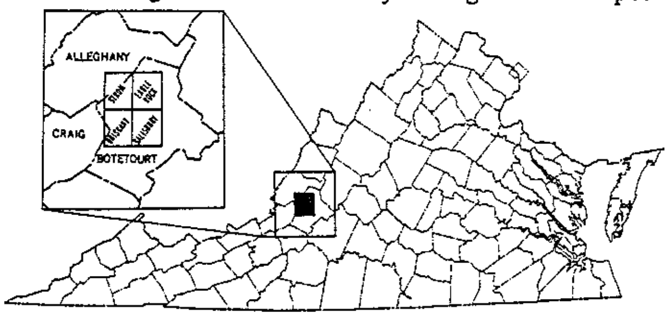

Figure 1. Virginia map showing the location of Eagle Rock Quadrangle (McGuire, 1970).

are located on the north side of the James River between Crawford and Rat Hole Mountains (Fig. 2). The Great Valley of Virginia is located west of the leading edge of the Blue Ridge Province in which Precambrian basement rocks are brought to the surface by thrust faults. West of the Great Valley of Virginia is the Valley and Ridge Province which is characterized by blind thrusts and broad folds.

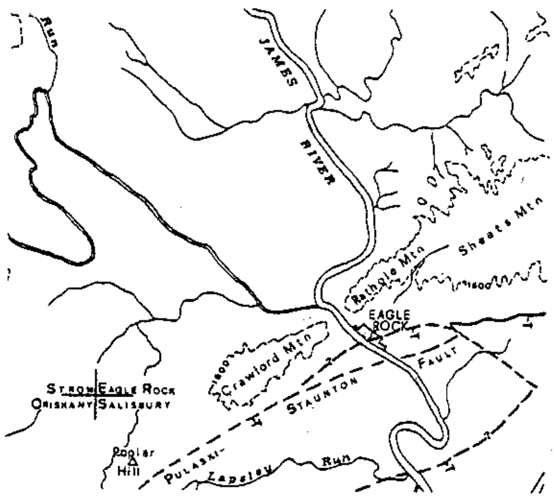

Figure 2. Map showing location of Eagle Rock Gap between Crawford and Rathole Mountains (McGuire, 1970).

A major fault which strikes parallel to the ridge at N50^{o} E and dips about 50^{o} to the northwest duplicates many of the Silurian formations in the exposure. The northwest dip of the fault is in the opposite direction and at a steeper angle than thrust faults mapped in the region, which generally dip gently to the southeast (Fig. 3).

Methods of Data Collecting

A cross section of the outcrop was prepared by measuring the positions of formation and fault contacts along the outcrop at road level. Field sketches were made and photographs were taken of structures in outcrop. Attitudes of major and minor fault planes, slickensides, bedding planes, and fold axes were measured with a Brunton compass. Orientations of structures were plotted on a stereonet. The positions of structures formed while bedding was

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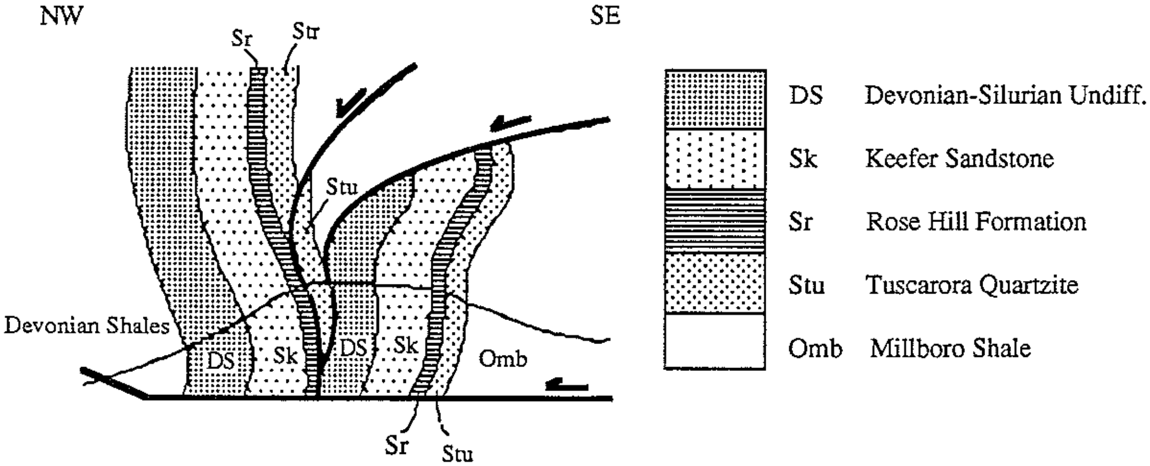


Figure 3. Cross section through Rathole Mountain.

still subhorizontal was determined by rotating the deformation out of tilted strata and then noting the orientations of structures.

Discussion

A model which accounts for the orientation of the major northwest dipping fault, as well as the positions of other faults and stratigraphic units to the northwest and southeast of the ridge, is an antiformal stack or foreland dipping duplex. The foreland dipping duplex is the result of the stacking up of horses developed at the ramp of a large thrust fault. In this case, the thrusts propagated to the northwest while each slice was pushed on top of the horse in front of it. The entire complex was ultimately pushed up over the ramp on to a roof thrust (Diegel, 1986).

The Pulaski-Staunton thrust fault, the western-most major thrust fault in the region, has been mapped as surfacing just southeast of the ridge by McGuire (1970), and on the northwest side by Bartholomew, Schultz, Henika, and Gathright (1982). In the foreland dipping duplex model proposed in this study, the basal detachment of the fault was in Cambrian rocks and then ramped up into the Devonian Millboro Shale. The systematic failure of this ramp resulted in the formation of four thrust faults and three thrust slices (Fig. 4). Fault 1 cut up stratigraphically to the Silurian Tuscarora Quartzite. Fault 2 reached the Devonian Millboro Shale, while fault 3 roofed in the Ordovician Edinburg Shale. These resulted in slices of different sizes and shapes. An undeformed and restored stratigraphic section is provided in Figure 5. The slices occur as lenses bounded by faults in map view. They are formed by the splitting and merging of thrusts. As the lense-shaped slice grows wider in the map view, the slice grows larger stratigraphically and encompasses more formations in cross section. Diegel (1985) noted a very similar geometry at the Limestone Cove duplex in Tennessee (Fig, 6).

Mesoscopic wedge faults which normally displace one or two beds and exhibit displacements up to two or three feet are found throughout the outcrop. Present attitudes of these faults were plotted on a stereonet, and the bedding was rotated back to horizontal (Fig. 7). In the undeformed position, the faults were oriented at N55^{o}E15^{o}S, which suggests that they were formed originally as low-angle reverse faults during initial compression when the beds were still subhorizontal (Bartholomew et al., 1982). The large scale thrusting took place as the result of later stresses with similar attitudes, and folding occurred in conjunction with the faulting and further compression. Extensional faults found in subhorizontal bedding of the Silurian Rose Hill Formation may be the result of tension developed as the duplex moved over the edge of the ramp on to the flat or as the result of the release of stress in the rocks after the compressional event (Hatcher, 1990). Other extensional faults may occur along steeply dipping bedding planes in other areas of the outcrop which results in what appears to be a localized extensional regime in the few subhorizontal bedded units of the Rose Hill Formation.

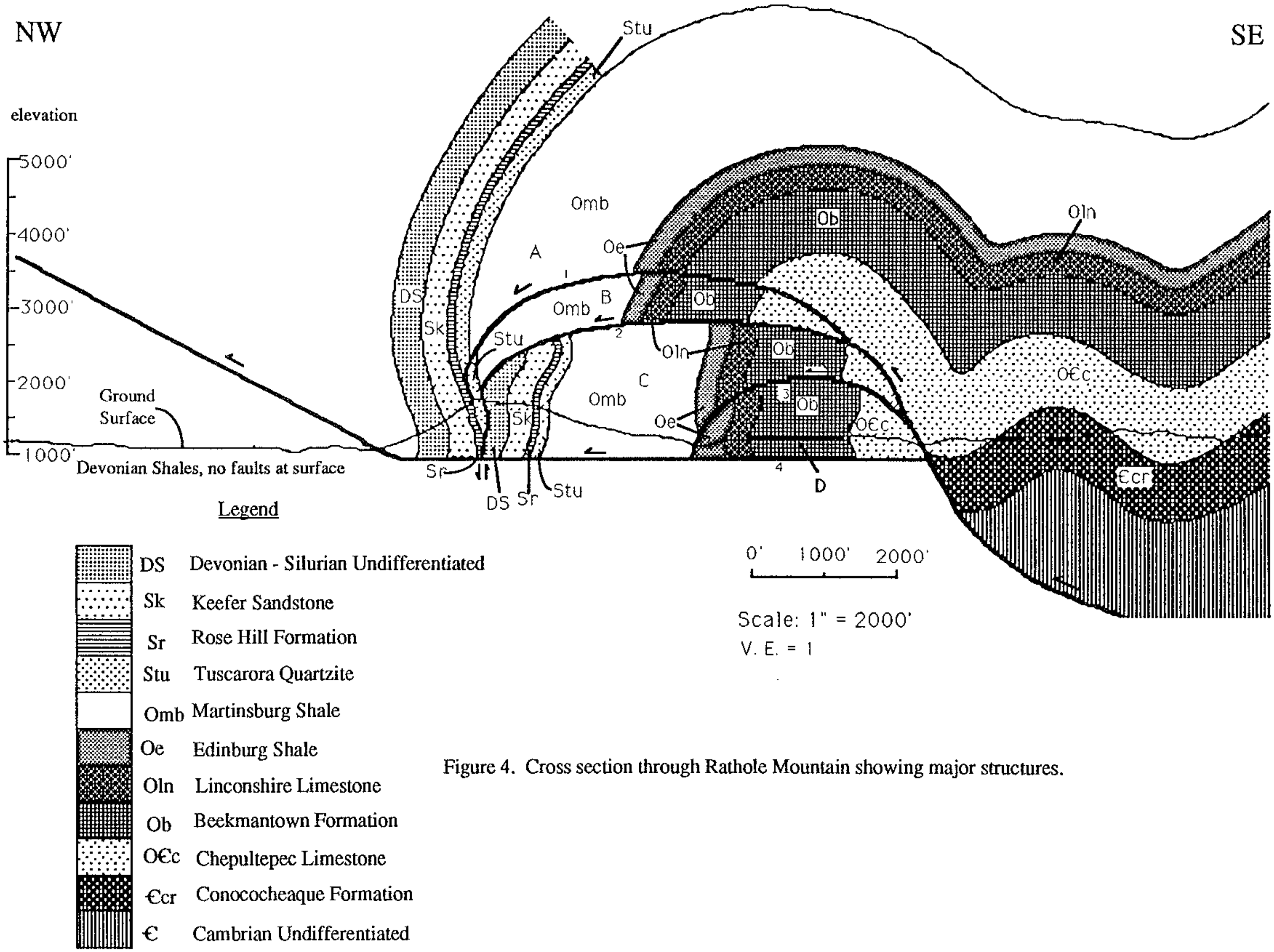


Figure 4. Cross section through Rathole Mountain showing major structures.

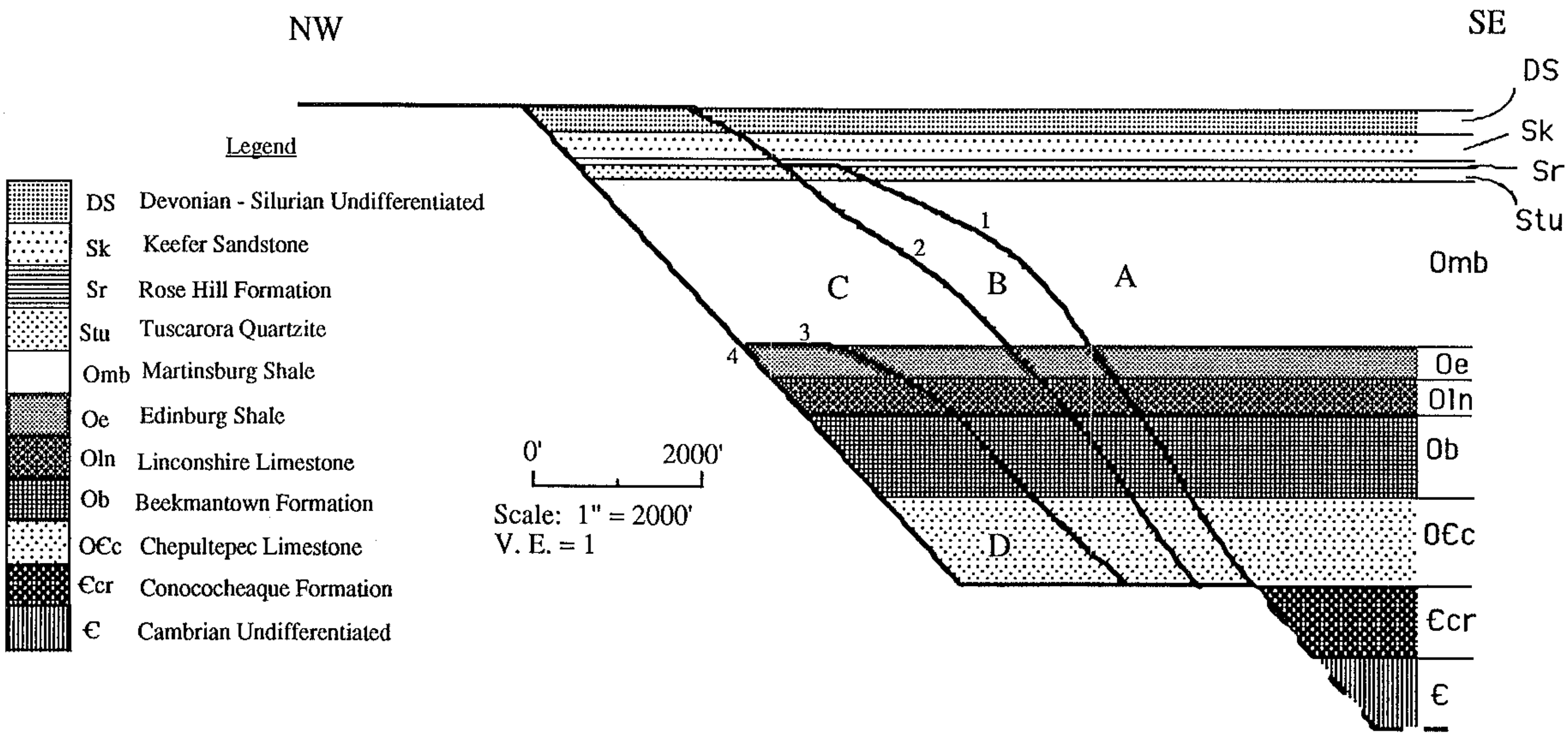


Figure 5. Undeformed and restored cross section.

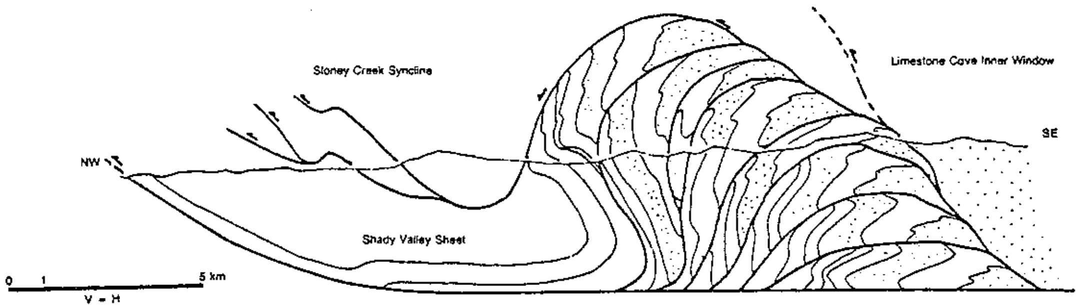
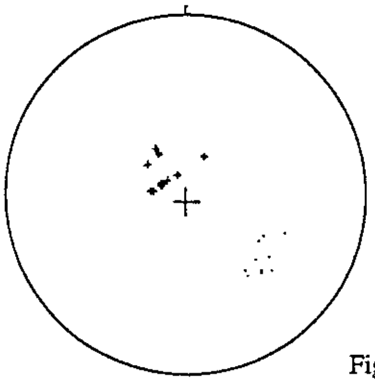


Figure 6. Cross section of Limestone Cove Duplex, Tennessee (Diegel, 1986).



+ = Undeformed Orientations n=10
. = Deformed Orientations n=10

Figure 7. Poles to Wedge Faults.

Conclusions

The following sequence of events is suggested:

a) Initial compression in which sigma-1 was oriented at N35°W, resulted in the formation of mesoscopic wedge faults.

b) Further compression with sigma-1 in a roughly parallel orientation resulted in the formation of large-scale faults, the stacking up of slices on the roof thrust, and the development of drag folds within the slices. In this model, the Staunton-Pulaski fault surfaces northwest of the ridge.

c) The cessation of movement along the major faults resulted in the formation of folds southeast of the duplex, and the formation of the folds in the major northwest dipping fault within the ridge.

d) The relaxation of regional compression. Extensional features formed at this time, or prior to this time if they are the result of deformation at the ramp edge.

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