Magnetic Mapping of Precambrian Greenstones in the Blue Ridge Mountains Near Buena Vista, Virginia

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The Blue Ridge region of the central Appalachians is a very complex geologic system consisting of structure from three separate orogenic episodes. The structure is a product of numerous faults and folds associated with the tectonic shortenings and extensions during Atlantic closing and rifting. The area in which this magnetic survey was undertaken lies on the western flank of the Blue Ridge Mountains. In part it crosses a formation known as the Blue Ridge Basement Complex. This formation consists of Precambrian granites dating back to the time of the Grenville Orogeny. One component of the complex, the Virginia Blue Ridge Basement unit, consists of leucocratic granulitic gneisses with some charnokite associations and has been dated to 1.1 billion years.(Rodgers, 1970) Nonconformably overlying the basement is the Early Cambrian Catoctin Formation, consisting of basaltic greenstones in association with graywackes, arkoses and tuffs. These basalts are linked with extensional faulting which occurred 600 to 575 million years ago. The Catoctin is exposed on the east side of the Blue Ridge Mountains, 5 miles east of Buena Vista on State Route 60. This area of greenstone exposure is know locally as the Oronoco Belt (Figure 1).

The goal of this project was to determine if contacts and faults common to the region could be detected using a proton procession magnetometer. A particular concern was to locate individual greenstone belts and determine their possible angle of dip. The survey proved feasible due to the difference in magnetic susceptibility between the basement gneisses and the overlying basaltic greenstones. The original granites of the Virginia Blue Ridge Basement have been metamorphosed into granulite gneisses and have an average magnetic susceptibility of $350x10^6$ emu. This contrasts with the iron rich basaltic greenstones which have an average susceptibility of $6000\ x10^6$ emu. (Telford et, al., 1976) This difference in magnetic susceptibility accounts for the acute differences in the signal of the basement granites and the basaltic greenstones.

The survey line extended eight miles southeasterly from the Blue Ridge Parkway in the north to the town of Willow, Virginia, in the south, across general basement contacts, greenstone belts, and finally the Blue Ridge Fault Zone (Figure 1). Readings were taken every 25 to 100 feet depending upon the magnetic change in the area. The magnetometer was consistently pointed north for the readings, and distances were measured using a standard measuring wheel. Care was taken to avoid power lines, guard rails and culverts which could cause interference and skew the data. Readings were taken at a base station at the beginning of the day on the intersection of State Route 60 and road 605. Substations were established daily and readings were taken there at least two other times during the day to account for diurnal drift. The magnetometer was calibrated to the regional setting of 55000 gamma prior to the beginning of the project. Data were recorded and put into a database graphing program on the Macintosh computer.

The data were graphed using Cricketgraph version 3.0. There are three major anomalies in the survey line (Figure 2). The northernmost (A) is located in the Pedlar Massif and made up of leucocratic granulitic gneisses. The anomaly lies in the interior of the massif and may indicate a dike within the gneisses which is common in the region. The amplitude of the curve is small due to deep burial or small size of the reactive unit. The curve on the actual line is doubled, that is two troughs and two peaks, because the survey intersected the unit twice as it rounded a hairpin corner.

The central anomaly (B) shows a much higher amplitude (about 2000 gamma), where the line crosses southward from Precambrian basement leucocratic gneisses into the Oronoco Belt near Oronoco. The strong anomaly is due to the shallowness and actual exposure of a wide band of greenstone at that point. The great depth of the positive curve, and the small horizontal distance between the high and the low may be attributed to a high dip angle of the greenstone. Southeast of this body, the magnetic signal decreases gradationally until another swarm of greenstones is intersected at Long Mountain Ridge.

The Long Mountain Ridge high is very unstable, with fluctuations over 1000 gamma in some areas (Figure 2, C). The unstable high is maintained until the Blue Ridge Fault is crossed. There, an immediate drop in magnetic activity occurs due to the low magnetic susceptibility of the gneisses making up the Blue Ridge Thrust Sheet. The abrupt change in magnetic signature suggests that the dip of the fault plane is quite steep in this area. Possibly the zone is ramping. Local landforms, in fact, support the notion of a thrust ramp. A steep valley is formed between route 60 and road 686 along the strike of the fault. The fault is exposed in the bottom of the valley. If the dip of the fault were shallow, a valley as deep as the one presently observed would not likely have formed.

This evidence is further corroborated by the anomaly at about 36000 feet on the survey line (Figure 2, D), where the Blue Ridge Fault is crossed near the Mount Horeb Church (Figure 1). The signal only increases as the survey line moves across the Blue Ridge Fault into the Oronoco Belt. The lower amplitude suggests a buried greenstone, while the abrupt appearance and disappearance of the signal supports the above notion of a steep fault dip.

Figure 1:

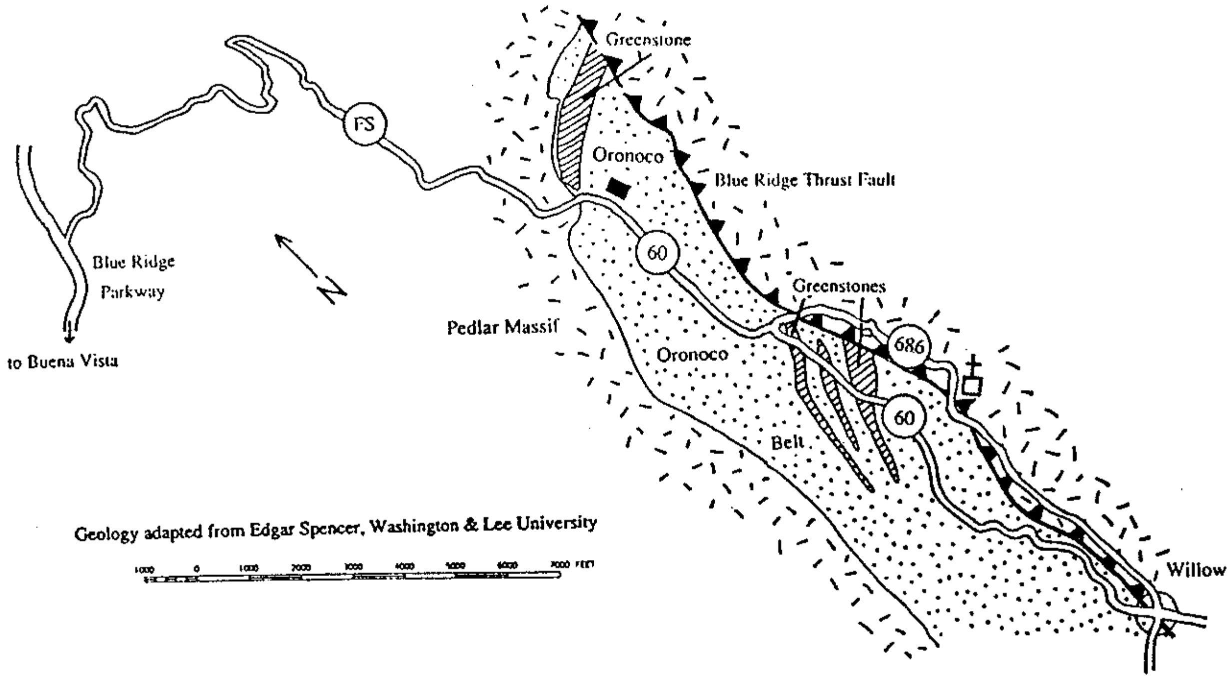
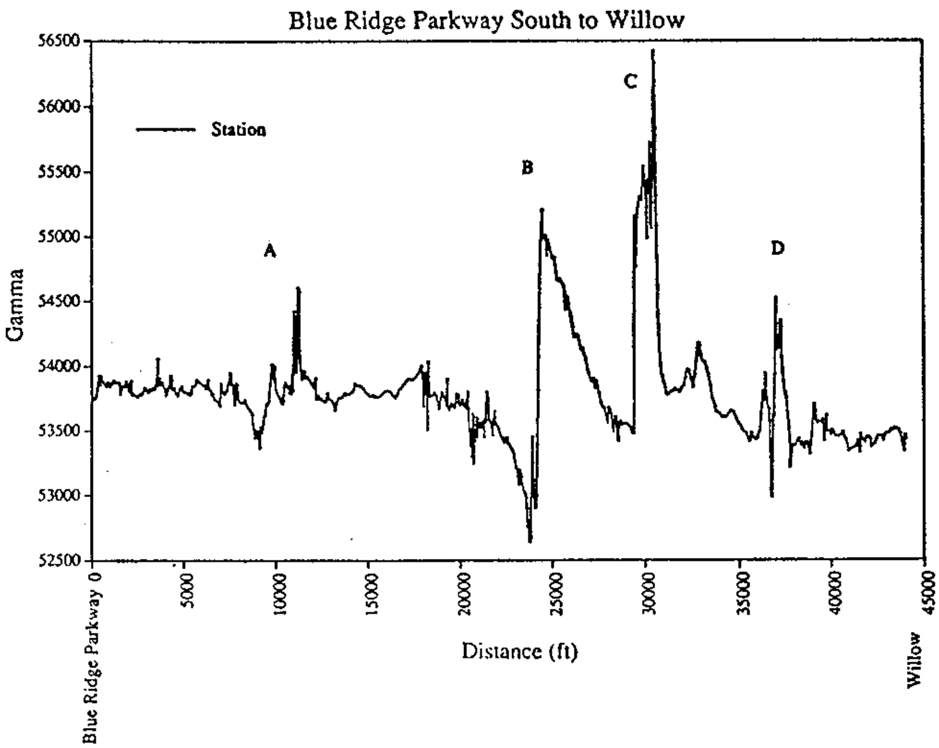


Figure 2:



References

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