A MAJOR CRUSTAL FEATURE IN THE SOUTHEASTERN UNITED STATES INFERRED FROM THE MAGSAT EQUIVALENT SOURCE ANOMALY FIELD

Michal E. Ruder and Shelton S. Alexander
Department of Geosciences
Geophysics Program
Pennsylvania State University
University Park, PA 16802

The Magsat equivalent-source anomaly field evaluated at 325 km altitude (Mayhew, et al., 1984) depicts a prominent anomaly centered over southeast Georgia. This -10 nT, 400 km feature is adjacent to the high-amplitude positive Kentucky anomaly. Together, the two anomalies share a 30 nT, 650 km gradient, the steepest in the conterminous United States equivalent source field. The Georgia negative anomaly extends northeast along strike of the Inner Piedmont geologic province, as far north as Virginia. To the southeast, it grades into an offshore negative anomaly which lies between the Blake Plateau and the Bahamas. in an attempt to overcome the satellite resolution constraint in studying this anomaly, we include conventional geophysical data in the analysis: Bouguer gravity, seismic reflection and refraction, aeromagnetic, and in-situ stress-strain measurements; through this integrated geophysical approach, we can infer more specifically the nature and extent of the crustal and/or lithospheric source of the Georgia Magsat anomaly. Physical properties (composition, susceptability contrast, crustal thickness) as well as tectonic evolution of the area are all important in the interpretation.

In assessing the nature of regional magnetic crust, we address four problems: What are the structural magnetic units of the southern Appalachians? What is the magnetic expression of the edge of the ancient craton? Does the magnetic crust reflect the seismic crust in this zone of low (< 1 HFU) heat flow? How useful is the equivalent source anomaly field in highlighting this anomalous crustal zone? Using this data set, what can we learn about crustal magnetization?

The study area has experienced both extensional and compressional tectonics. Precambrian rifting and normal faulting gave way to Paleozoic compression and overthrusting. Accretion of terranes and three successive orogenic episodes occurred during this era. The Appalachian decollement and other indications of thin-skinned tectonics are superimposed Paleozoic features. A dramatic change to an extensional stress regime led to Mesozoic rifting and the successful opening of the Atlantic Ocean. The modern stress field is characterized by northeast maximum horizontal compressive stress (Zoback and Zoback, 1980, 1984), probably generated by ridge-push from spreading along the Mid-Atlantic ridge.

The Appalachian orogen, as well as the Georgia anomaly, is comprised of allochthonous terranes (Hatcher and Williams, 1982). Identified terranes whose dimensions are on the order of Magsat's spatial resolution include the Piedmont, Avalon, Brunswick, and Tallahassee. The Piedmont terrane is characterized by linear aeromagnetic anomalies and near-surface mafic and ultramafic rocks. Precambrian sedimentary and volcanic (calc-alkaline to tholeiitic) rocks are found in the Avalon. These are expressed as high-frequency, short-wavelength aeromagnetic anomalies. The Brunswick and Tallahassee terranes are obscured by Coastal Plain sediments. Unlike the Avalon and Tallahassee terraines, the Brunswick contains broad-wavelength aeromagnetic signatures.

Within these individual terranes, prominent geophysical features outline large-scale crustal blocks. Although it is best experienced as a magnetic anomaly, the northeast-trending New York-Alabama Lineament (King and Zietz, 1978), it also correlates with Bouguer gravity. The feature may repreent a Paleozoic or older subduction zone or a major strike-slop basement fault. To the southeast lies the Appalachian gravity low and northeast-trending anomalies. North-trending anomalies are found northwest of the New York-Alabama lineament. The Clingman lineament (Nelson and Zietz, 1983), another aeromagnetic linear feature within the study area is located 60 km to the east; it likely represents a basement structural discontinuity, as well. The region of eastern Tennessee which lies between these two linear features has the highest seismicity of the southern Appalachians (Johnson, et al., 1984).

The large amplitude, paired negative and positive Bouguer anomaly, the Appalachian gravity gradient, transects the Inner Piedmont. Its northeast trend through the study area may outline the edge of the ancient North American craton. The gradient has been modeled as a suture by Hutchinson, et al. (1983) and its flexural properties have been investigated by Karner and Watts (1983).

Although seismic reflection profiling represent the clearest geophysical crustal imaging technique, COCORP results in the study area are ambiguous. According to Cook et al. (1979), the decollement is resolved throughout the region. However, reprocessed sections interpreted by Iverson and Smithson (1983) indicate that the detachment root zone is located in the Piedmont, and no midcrustal reflectors are identified east of this province. The nature of the detachment remains an unsolved question, central to the tectonic interpretation of the study area.

Our preliminary results indicate that the Georgia magnetic anomaly is caused by a large volume of low susceptibility material distributed through the entire lower crust beneath the decollement. The argument for the alternative of a thinned magnetic crust is eliminated upon examination of the low heat flow (no elevated Curie isotherm) and crustal thickness estimates from seismic data. Forward modeling results of Ruder and Alexander (1984) show a four-body model with vertical and lateral susceptibility discontinuities can reproduce the general features of the anomaly field. By incorporating the geophysical evidence discussed above, crustal magnetization blocks are presently being further delineated by aeromagnetic lineaments, the gravity gradient and seismic profiling results. It appears that major magnetization units may be correlated with the allochthonous terranes present in the study area, and hence with the regional tectonic fabric.

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