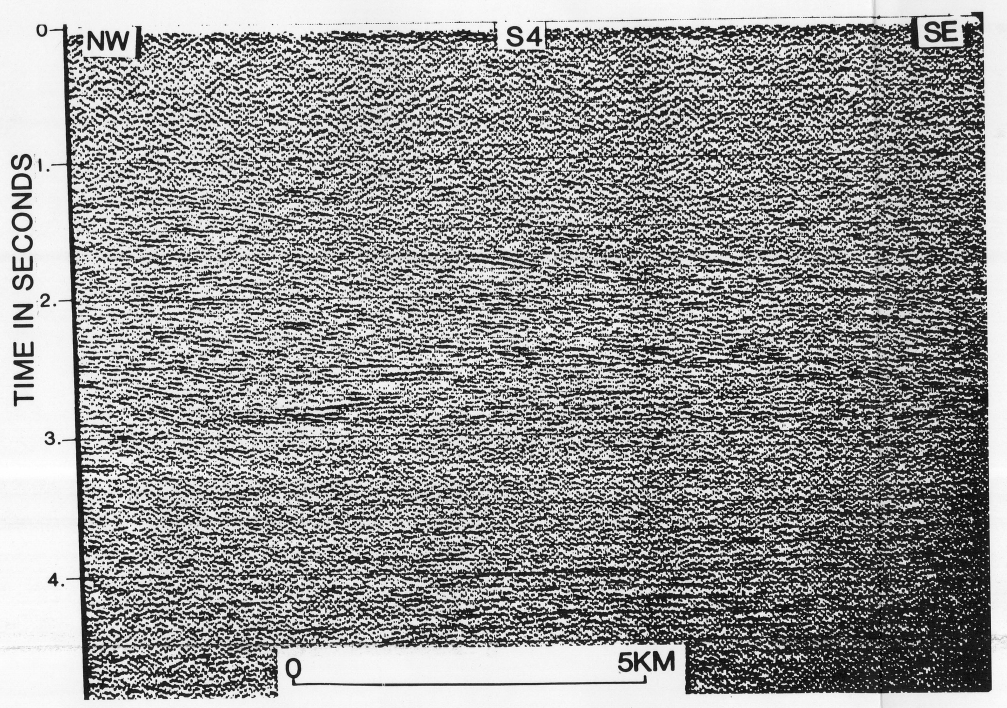
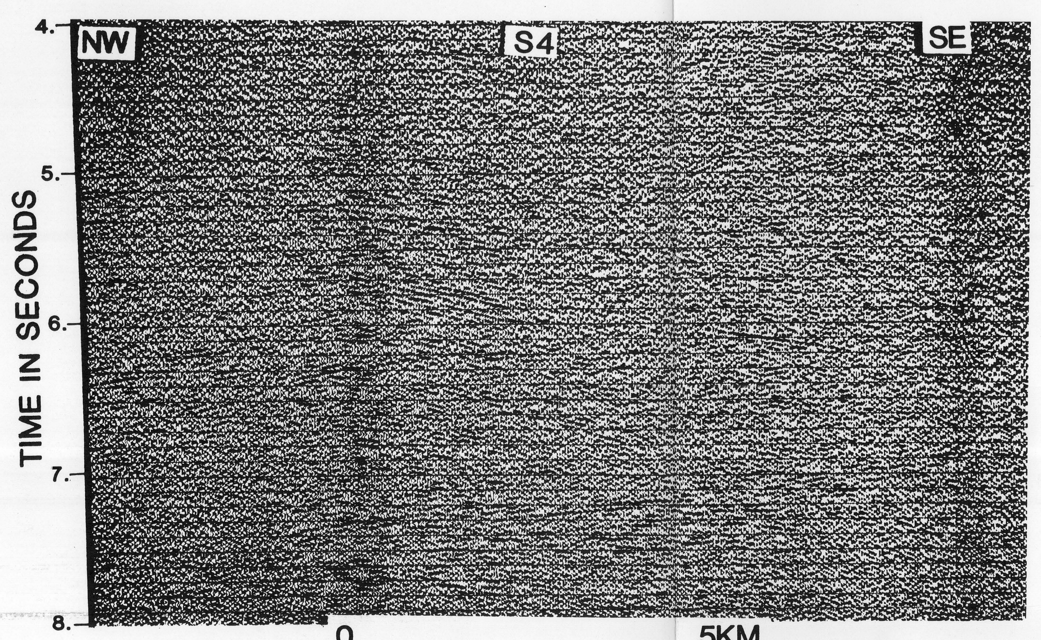
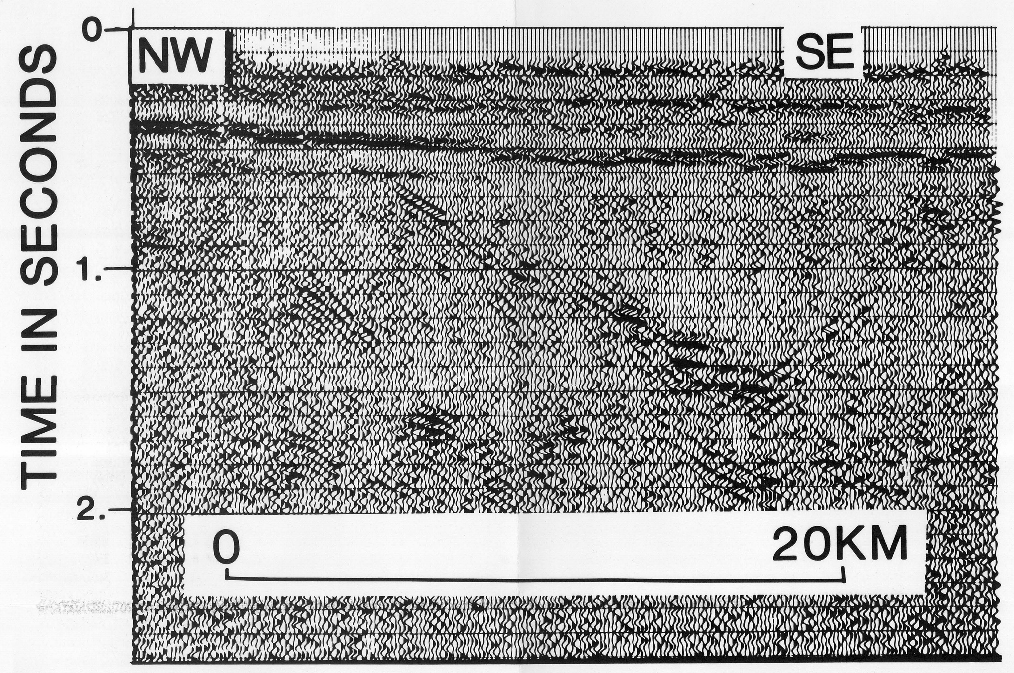
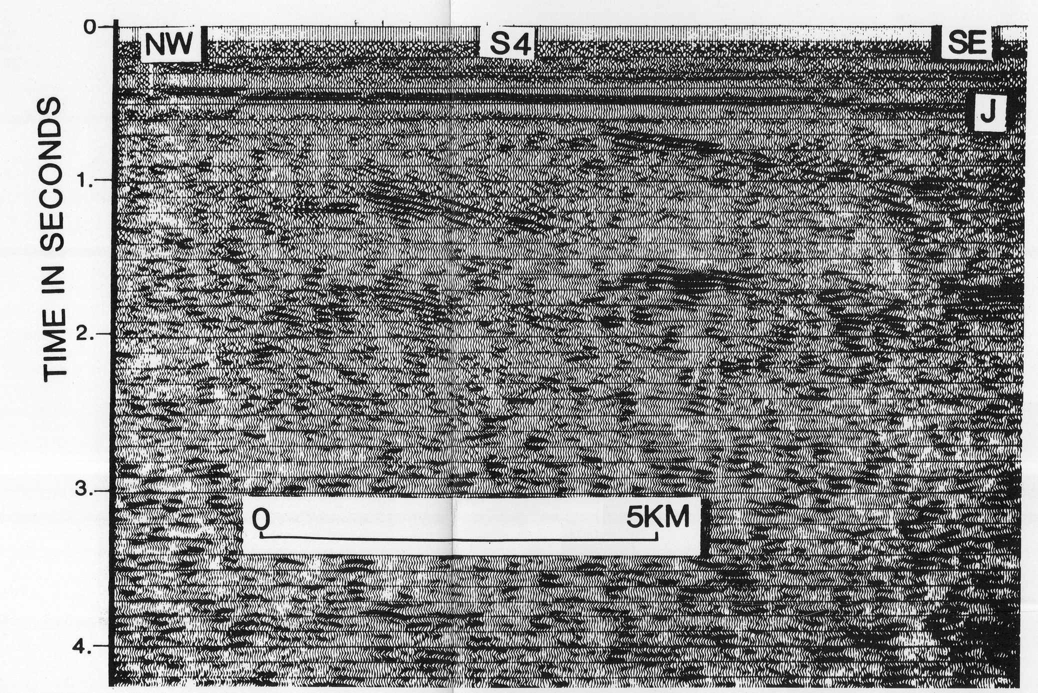


Example from seismic record section crossing the Carolina slate belt, showing reflections and diffractions.

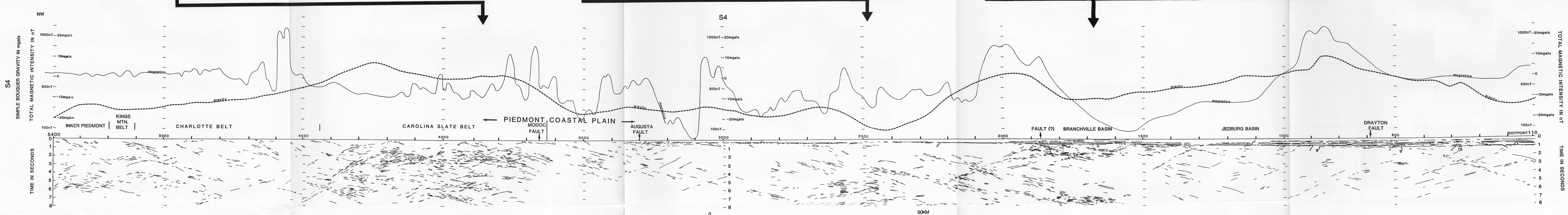


Example from seismic record section crossing the Coastal Plain, showing deep reflections and diffractions.



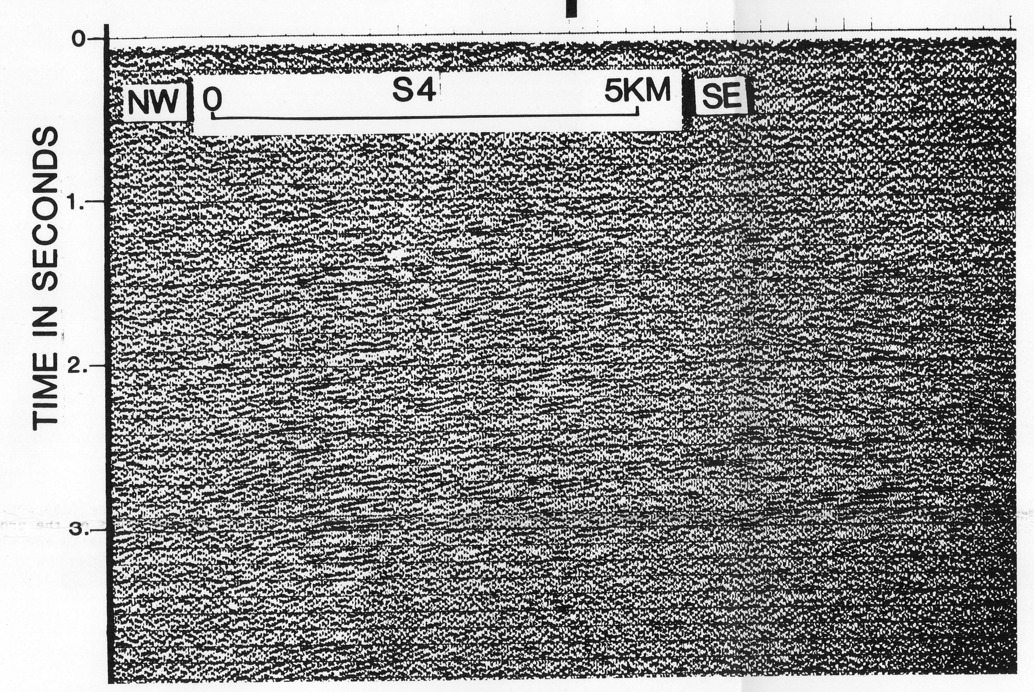


Two examples from seismic record section crossing Branchville basin. Left figure displays every fourth trace only. Note suggestion of faulting inferred from small offset in J reflection.

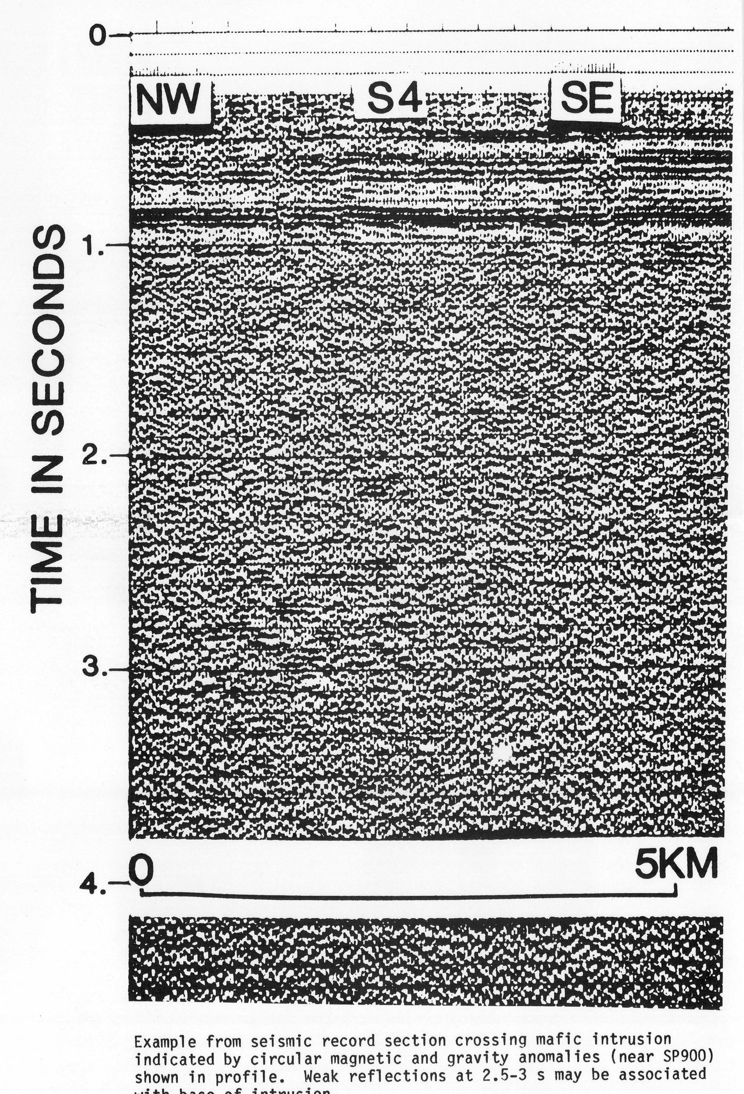


Line-drawing interpretation of unmigrated record sections for seismic-reflection profile S4. Data are 96 channel, 24 fold. Shotpoints (vibration points) at 134-m intervals are indicated at top of section and on map. Magnetic and gravity profiles were compiled from USGS data. Geology is from Hatcher and others (1977) and from Williams (1978). Some of apparent features are coastward-dipping reflections from faults, strong diffractions from beneath Carolina slate belt, J reflection marking base of Coastal Plain sedimentary sections, B reflection marking inferred basement in southeastern part of the line, and Branchville and Jedburg Triassic(?) basins and suggested associated faults. No evidence of Appalachian décollement is present in northwestern part of line; several diffractions in the southeast and possible reflections from base of a truncated pluton near SP 850 suggest existence of Charleston décollement in this area. Several examples from record section are shown.

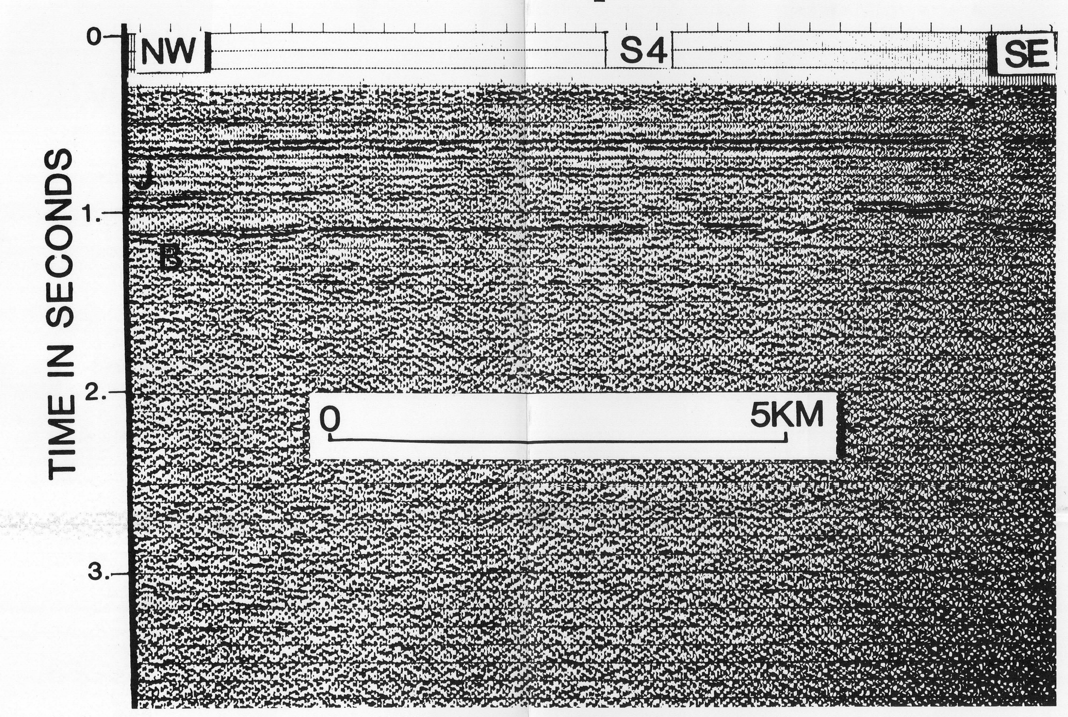
Note: Arrows extending from examples of record sections to the line interpretation are meant to show generally the areas which the sections represent.



Example from seismic record section crossing the Carolina slate belt, showing reflections and diffractions.



Example from seismic record section crossing mafic intrusion indicated by circular magnetic and gravity anomalies (near SP900) shown in profile. Weak reflections at 2.5-3 s may be associated with base of intrusion.



Example from seismic record sections showing J reflection (absent in places) from basalt layer and B reflection from inferred basement.

INTRODUCTION

Over the past decade, the U.S. Geological Survey (USGS) has been investigating the cause of the Charleston, S.C., earthquake of 1886 and the likelihood of future earthquakes of similar magnitude (m_b 6.9-7.2, Bollinger, 1977). As part of that work, multichannel reflection surveys were started in 1979 in the Charleston area, on land (Behrendt and others, 1981; Hamilton and others, 1983) and offshore (Behrendt and others, 1983). The data for lines across the continental margin were tied into the USGS offshore seismic grid in the area discussed by Dillon and others (1979). At about the same time (1978-79), Consortium for Continental Reflection Profiling (COCORP) lines in Georgia and in the Charleston, S. C., area were recorded (Cook and others, 1979; Cook and others, 1981; Schilt and others, 1983). The COCORP data for Georgia (Cook and others, 1979) and other reflection data to the northeast, as discussed by Harris and Bayer (1979), indicated the presence of the Appalachian décollement, extending seaward from the Appalachian Mountains. The authors of these papers inferred that the Appalachian décollement might extend across the Piedmont and Coastal Plain to the continental shelf. Subsequently, Iverson and Smithson (1982) suggested, on the basis of their reprocessing of the COCORP line in Georgia, that the décollement was rooted in the area of the Kings Mountain and the Carolina slate belts.

The multichannel seismic-reflection data for the Charleston, S. C., area (Behrendt and others, 1981, 1983; Schilt and others, 1983) provided evidence, particularly strong offshore, of the existence of a reflecting surface at a depth of 11.4±1.5 km that was suggested as a décollement. Behrendt and others (1981, 1983) suggested that the Charleston earthquake of 1886 might have been caused by movement on the décollement or on associated listric faults. Seeber and Armbruster (1981) suggested that movement on the Appalachian décollement, if it continued coastward to Charleston, might have caused the Charleston earthquake of 1886. The best determined focal depths for recent seismicity, from data recorded by a seismograph network operated by the USGS in the Charleston, S. C., area since 1973, are shallower than 13±2 km (Tarr and others, 1981; and Tarr and Rhea, 1983), or above the suggested décollement.

The seismic-reflection data have also shown the existence of several Triassic(?) basins beneath the Coastal Plain Late Cretaceous and Cenozoic sedimentary rock section (Behrendt and others, 1981; Behrendt, 1983; Costain and Glover, 1983; Hamilton and others, 1983; Petersen and others, 1984). The basins, in several cases, appear to be bounded by high-angle normal faults. Some of these faults may have been reactivated in Late Cretaceous and Cenozoic time as apparently reverse faults. Also they are suggested to be listric onto the décollement, thereby bearing a causal relation to Charleston seismicity (Behrendt, 1983; Behrendt and others, 1983).

The question of whether the Appalachian décollement is continuous to the coast is, therefore, important not only for the general understanding of the tectonics of the southeastern United States but for an understanding of the earthquake-hazard question as well. For these reasons, three long, deep-crustal, multichannel seismic-reflection profiles (S4, S6, and S8) were obtained by the USGS to address the problem. This report presents illustrations of interpretations of the profiles discussed by Behrendt (in press).

The Appalachian décollement does not appear continuous from the Appalachian Mountains to the coast but rather appears to extend southeastward only to the Carolina slate belt. A series of reflections on lines S4, S6, and S8 and on the COCORP line is interpreted as evidence of southeastward-dipping imbricate faults, from the Brevard fault on the northwest to beyond the Augusta fault, which marks the southeastern extent of the Eastern Piedmont fault zone. The Carolina slate belt is characterized on the four seismic profiles by a complex series of diffractions and reflections extending from less than 1 s to 8 s. These arrivals are possibly the result of layering in the metasedimentary rocks complexly disrupted by the imbricate faults. A number of Triassic(?) basins are apparent in the reflection data for the rifted Charleston terrane identified from low-gradient magnetic anomalies.

DEEP-CRUSTAL REFLECTION PROFILES

Description of Data

The map shows the location of the three multichannel seismic profiles crossing South Carolina and Georgia acquired by USGS, the COCORP reflection profile, from Cook and others (1981), discussed above, and other USGS data offshore. Lines S4, S6, and S8 were contracted on a non-exclusive basis, with the USGS as an original participant, and collected in 1981. The spread length was 6.7 km, group interval 67 m; there were 24 geophones per group, and 96 channels. The shotpoint (vibration point) was at the center of the spread, 100 m from the groups on either side. Four vibrators were used for the VIBROSEIS [1] (Continental Oil Co. trademark) data collection, and shotpoints were spaced at 134-m intervals; the sweep length of 24 s was down from 48-12 hz. The sample rate was 4 ms, and the record lengths were 8 s for line S4 and 6 s for lines S6 and S8. The data, as discussed and illustrated in this report, were processed 24 fold by the contractor and have not been migrated. Originally, only the record sections obtained from the contractor were available, and the interpretations presented here were made using these. Recently, the field tapes have been acquired, and additional processing, including migration, is planned. The S4, S6, and S8 data are generally superior in quality in the upper 2 s to the COCORP line, but of course do not have as deep a penetration because they have short 6-s and 8-s record sections.

[1] Any use of trade names is for descriptive purposes only and does not imply endorsement by U.S. Geological Survey.

Geologic Setting of Profiles

The profiles S4, S6, and S8 shown here extend from the Appalachian Mountains to the coast, crossing along the way the Piedmont province of Paleozoic crystalline rocks and the Coastal Plain province of Late Cretaceous and Cenozoic sedimentary rocks. Williams and Hatcher (1982) have described the various northeast-trending accreted terranes that they interpret as making up the pre-Cretaceous rocks of the area. Also, Hatcher and others (1977) defined the extent of the northeast-trending eastern Piedmont fault system that has probably been active in various senses of movement from Paleozoic to possibly the present time, as suggested by the recent seismicity. Geologic features indicated along the interpreted seismic profiles discussed below are taken from these papers and from Williams (1978).

Interpretations of Seismic Record Sections

In making the interpretations presented in this report, all of the lines on the profiles S4, S6, and S8 were produced by visually correlating a large number of adjacent seismic traces from characteristic wave forms, even though the lines may not be as continuous as in sedimentary rock sections (for example, the J reflection from the pre-Cretaceous unconformity shown in the line drawings at the base of the Coastal Plain section). Of course, some multiple reflections may have inadvertently been identified, and certainly there are many diffractions shown. Nonetheless, I am reasonably confident that all of the arrivals indicated in these time sections have their origin in the convolution of seismic waves with geologic structures.

A different level of subjectivity is involved in identifying the events indicated in the line drawings. I have labeled certain reflections along the northwest ends of profiles from S6 and S8 as "D" to indicate my inference that they are from a décollement. In like manner, I used "D" at the southeast end of S8 to suggest a correlation with the surface offshore mapped by diffractions (many of which migrated to flat reflections), also inferred to be from a décollement (Behrendt and others, 1983) called "the Charleston décollement" (Behrendt, in press).

The gravity and magnetic profiles shown along the tops of the figures were compiled from U.S. Geological Survey unpublished data for this area at 1:250,000 scale, published at 1:2,000,000 scale by Zietz and Gilbert (1980).

ACKNOWLEDGMENTS

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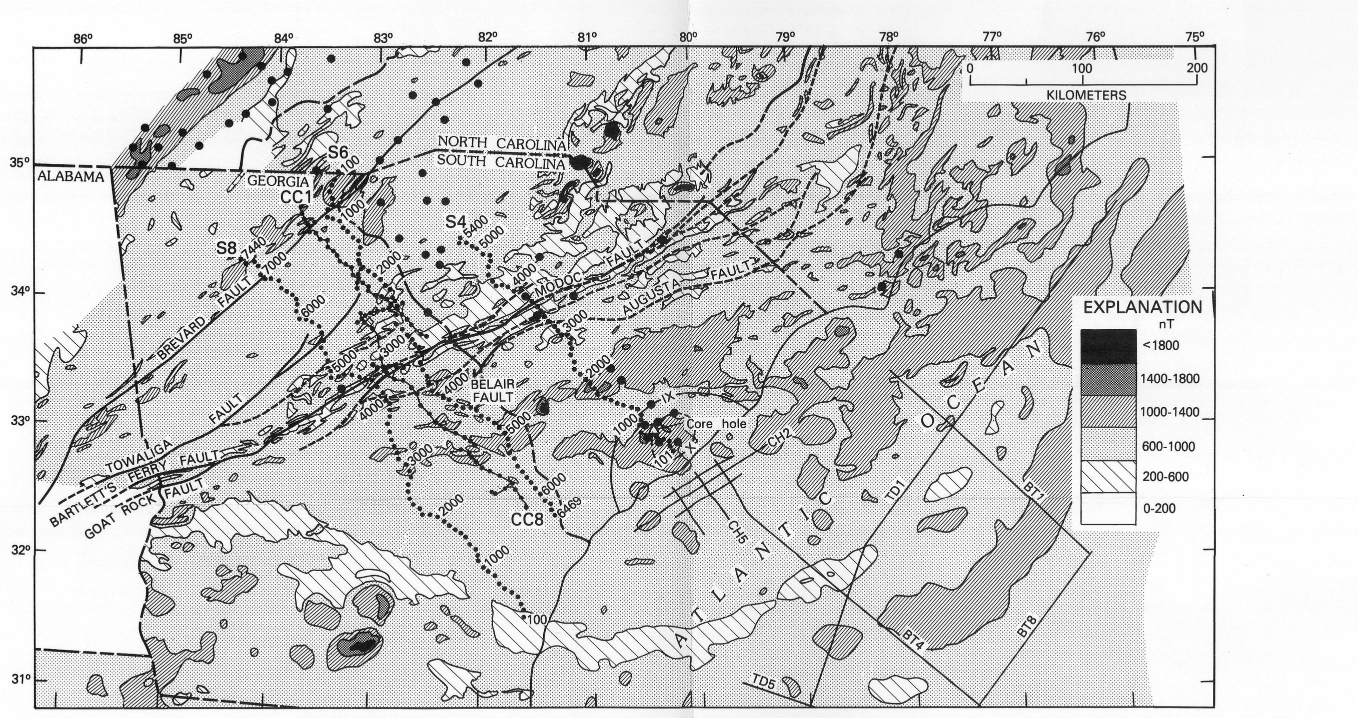

Aeromagnetic map modified from Zietz and Gilbert (1980), covering South Carolina, part of Georgia, adjacent states, and the continental margin. Contour interval is 400 nT. Map shows faults of eastern Piedmont fault system (Hatcher and others, 1977) and all multichannel seismic lines 5 s or greater in time. Deep-crustal, multichannel seismic-reflection lines S4, S6, S8, shotpoints indicated, and COCORP lines CC1-CC8 (Cook and others, 1981) shown on land. Marine lines CH2, CH5, and adjacent CH grid (Behrendt and others, 1983) and BT1, BT4, BT8, TD1, TD5 (Dillon and others, 1979) are indicated. Intensity IX and X isoseismal lines in the meizoseismal area of Charleston earthquake of 1886 are shown, from Bollinger (1977). Epicenters shown are instrumentally redetermined for earthquakes prior to 1974 (Dewey, 1983). Jedburg and Branchville basins are crossed by S4 between shotpoints 900 and 1800. Zone of low magnetic gradient used to define Charleston terrane can be seen southeast of S4, shotpoint 1700, and north of Brunswick anomaly, which crosses coast in an arcuate east-west trend about 75 km north of Georgia-Florida state line.

INTERPRETATIONS FROM MULTICHANNEL SEISMIC-REFLECTION PROFILES OF THE DEEP CRUST CROSSING SOUTH CAROLINA AND GEORGIA FROM THE APPALACHIAN MOUNTAINS TO THE ATLANTIC COAST

By
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