

STUDY OF SOUTHERN OKLAHOMA AULACOGEN, USING COCORP DEEP SEISMIC-REFLECTION PROFILES

J. A. Brewer

INTRODUCTION

The Southern Oklahoma Aulacogen, the type aulacogen in the United States, is a major structural feature in the southern Midcontinent region. For the purposes of this paper, I define the aulacogen in the region of the COCORP¹ traverse as including the Hardeman Basin, Wichita Mountains, and Anadarko Basin, although there is some confusion in the literature over the exact use of the term and the age of onset of the aulacogen. The Anadarko Basin is the deepest basin in the North American craton (Ham and Wilson, 1967) and the site of intensive oil and gas exploration since the turn of the century. However, relatively little is known of the deepest parts of the basin, especially in the complexly deformed area close to the Wichita Uplift; knowledge of the uplift itself is based on relatively shallow well data and studies of exposed igneous rocks.

From such data, Ham and others (1964) proposed that the first major event in the evolution of southern Oklahoma (apart from the formation of the crystalline basement) was Early Cambrian subsidence of a trough, centered beneath the present Anadarko Basin and Wichita Uplift, and thought to be filled largely with clastic metasediments (Tillman Metasedimentary Group). This trough was intruded by gabbros and overlain by basalts, subjected to uplift and erosion, and further overlain by rhyolites and intruded by granites. These intrusive rocks consolidated into what is now the Wichita block. Subsequent (Late Cambrian–Permian) subsidence was concentrated north of the Wichita block, and deformation culminated in the Pennsylvanian with uplift of the Wichita block and subsidence to the north, forming what are now the Wichita Mountains and Anadarko Basin. Thus, the present mountains and basins all lie within Ham and others' (1964) inferred Early Cambrian trough. Subsequent radiometric dating (Muehlberger and others, 1967) suggests that the Tillman Group is at least 1,000 m.y. old, or twice as old as the granites in the Wichita Mountains (500–525 m.y.; Ham and others, 1967), thus raising questions about the significance of the Tillman Group in the Paleozoic structural evolution of southern Oklahoma.

Hoffman and others (1974) interpreted Ham and others' (1964) evolutionary scheme in a plate-tectonic framework, suggesting that the inferred Early Cambrian trough formed during an ex-

tensional episode in which continental crust to the east and southeast rifted completely away from the North American craton. Although the southern Oklahoma trough failed to extend very far (a "failed rift arm"), the region continued subsiding through most of Paleozoic time. The culmination of deformation in the Pennsylvanian was related to closure of the arms that rifted successfully, and formation of the Ouachita belt. This final deformation of the Southern Oklahoma Aulacogen has been considered by most workers (for example, Harlton, 1963, 1972; Wickham, 1978) to be due to vertical or strike-slip movements along predominantly high-angle faults.

COCORP deep seismic-reflection profiling was carried out in southwestern Oklahoma to study the deep structures of the aulacogen and to determine its structural development. Three new aspects of the aulacogen are inferred from the data: (1) it is aligned along the northern margin of a hitherto unknown Proterozoic basin; (2) crustal extension occurred in late Precambrian–Early Cambrian time, with normal faulting in what is now the deepest part of the Anadarko Basin; (3) major crustal shortening occurred in Pennsylvanian time, causing the Wichita Uplift to overthrust the Anadarko Basin along moderately dipping faults. Listric thrust faulting and hanging-wall anticlines formed in the sedimentary rocks of the Anadarko Basin, which at this time was probably subsiding from thrust-loading of its southern margin. These interpretations thus suggest significant revision of ideas of the basement structural framework and style of deformation of the aulacogen.

LOCATION OF COCORP LINES

The COCORP data were recorded in three phases (figs. 24, 25): (1) the first COCORP surveys ever conducted, in 1975, in the Hardeman Basin, Hardeman County, Texas (Oliver and others, 1976); (2) in 1979, continuing the 1975 work farther north, in the Hardeman Basin and through the Wichita Mountains (Brewer and others, 1981); (3) in 1980, extending the surveys still farther north across the Frontal Fault system of the Wichita Mountains and through the Anadarko Basin, ending in Northern Dewey County, Oklahoma (Brewer and others, 1982). The surveys thus extend across the width of the Southern Oklahoma Aulacogen. The data were collected by the Vibroseis² technique, and field configurations and recording parameters were similar to those described by Oliver and others (1976).

¹ COCORP is an acronym denoting Consortium for Continental Reflection Profiling.

² Trademark of Continental Oil Co.