GEOLOGY OF THE SUPERCONDUCTING SUPER COLLIDER PROJECT AREA

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INTRODUCTION

The site selected for the Superconducting Super Collider (SSC) is located in Ellis County in North-Central Texas. The area is located on the rolling prairies near the margin of the West Gulf Coastal Plain (1). The White Rock Escarpment (west of the site) marks the western limit of the east-dipping Austin Chalk. The Eagle Ford Prairie extends westward from the White Rock Escarpment. The Blackland Prairie is developed on the Taylor Marl, which overlies the Austin Chalk.

The project area lies within the Trinity River drainage basin and is characterized by a flat to gently rolling topography dissected locally by streams. Relief in the region is approximately 350 ft (107 m). Surface elevations along the line of the SSC tunnel range from about 460 ft to 740 ft (140 to 225 m).

GEOLOGY

Four stratigraphic intervals of Upper Cretaceous rocks are impacted by the SSC Project (Fig. 1). These intervals include the lower unit of the Taylor Group, three unnamed units in the Austin Group, and the uppermost unit of the Eagle Ford Group. The lower unit of the Taylor is a marl (calcareous claystone), the Austin Group consists primarily of chalk, and the upper part of the Eagle Ford is predominantly shale.

Bedrock formations are overlain locally by Quaternary age alluvial deposits along stream courses. Alluvial sediments are composed of calcareous clays, sands, and gravels and range from 5 to 30 ft (1.5 to 9 m) thick.

The regional dip of the Cretaceous strata in this area is toward the east-southeast at about 90 ft (27 m) per mile. The bedrock is disrupted locally by faults and fractures related to the Balcones Fault Zone.

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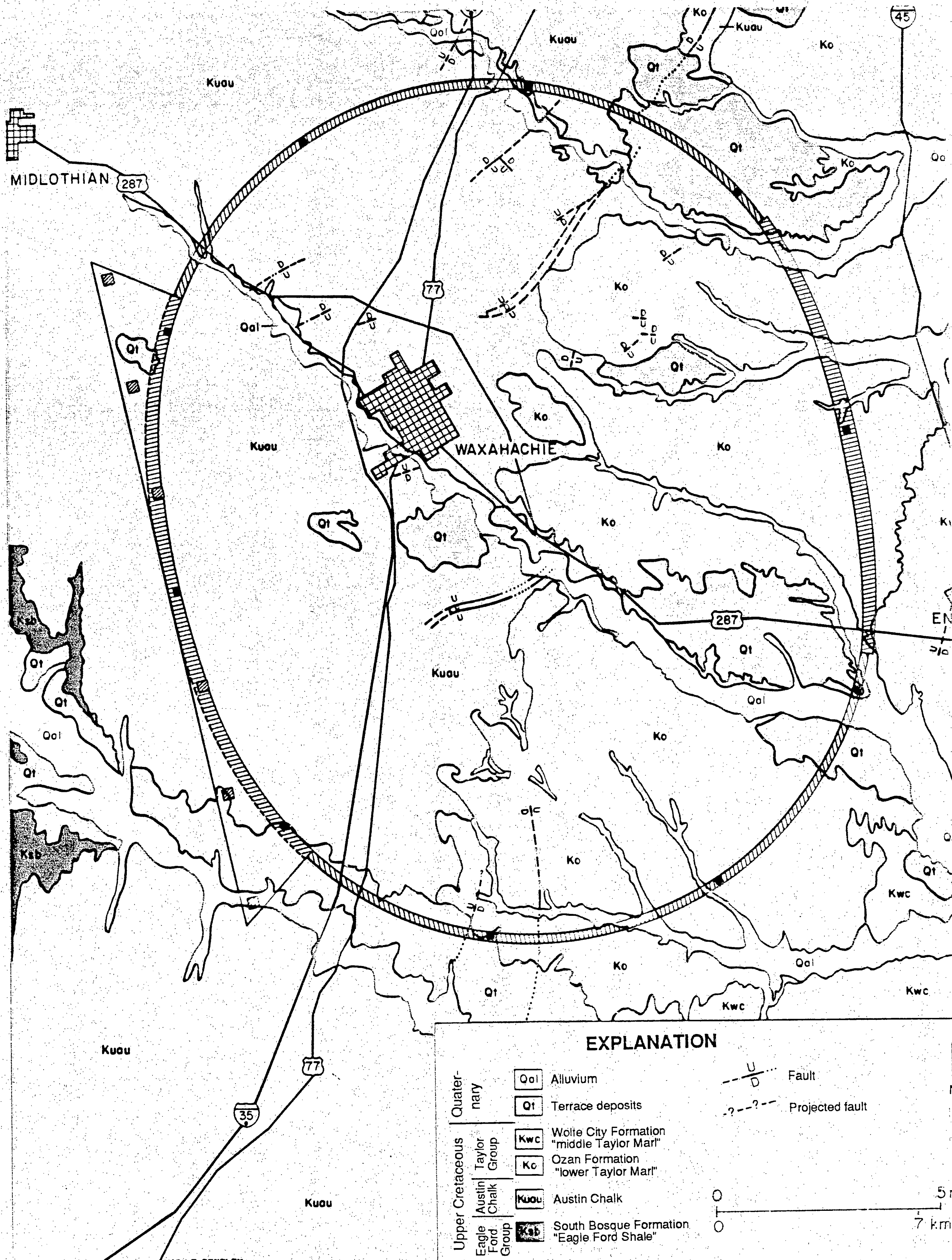

Figure 1. Generalized geologic map of the SSC area.

STRATIGRAPHY

Quaternary Deposits

Alluvium and Terraces

Quaternary deposits in the vicinity of the SSC site are composed of Alluvium and Terrace deposits (Fig. 1). These sediments are the result of deposition by ancestral and modern streams.

Alluvium includes unconsolidated sediments in modern stream channels and low terraces that are frequently flooded. In this area Alluvium generally contains a high proportion of gray to tan cohesive calcareous clay, silt or sandy clay overlying more granular sands, and gravels that commonly contain water. Thickness of Alluvium ranges from 5 to 25 ft (1.5 to 8 m).

Terrace deposits are topographically higher than the modern floodplain and are composed primarily of unconsolidated dark-gray to tan calcareous sand, silt, clay, and gravel. The basal parts of the Terrace deposits commonly include water-bearing sands and gravels. Materials were derived primarily from erosion of Cretaceous bedrock present in the drainage basin of the streams and rivers. Thicknesses of the Terrace deposits commonly range up to 30 ft (9 m).

Cretaceous Deposits

Taylor Marl

The Taylor Group is subdivided into four lithologically distinct formations (Fig. 2): the Lower Taylor Marl or Ozan Formation; Wolfe City Formation; Pecan Gap Chalk; and Marlbrook Marl (2, 3). Only the Wolfe City Formation and the Ozan Formation are present at the SSC site in eastern Ellis County. The marls of the Ozan Formation will be intersected by the proposed SSC facility at depth and on the surface. For the purposes of the SSC Project, the name Taylor Marl (Fig. 1) is used for the Ozan Formation in the project area.

The Taylor Marl is a medium-gray to bluish-black laminated calcareous marine shale containing fossil fragments and calcite veins. The fresh, blocky shale displays conchoidal fractures but develops fissility upon weathering. Fresh exposures are bluish-black or gray. The alteration of finely disseminated pyrite and presence of pyrite nodules in the Taylor Marl produce orange limonite stains in weathered exposures. Secondary gypsum is commonly present along bedding planes and joints in weathered zones. Soils developed on the Taylor Marl are dark gray clays and clay loams that have a high shrink-swell potential.

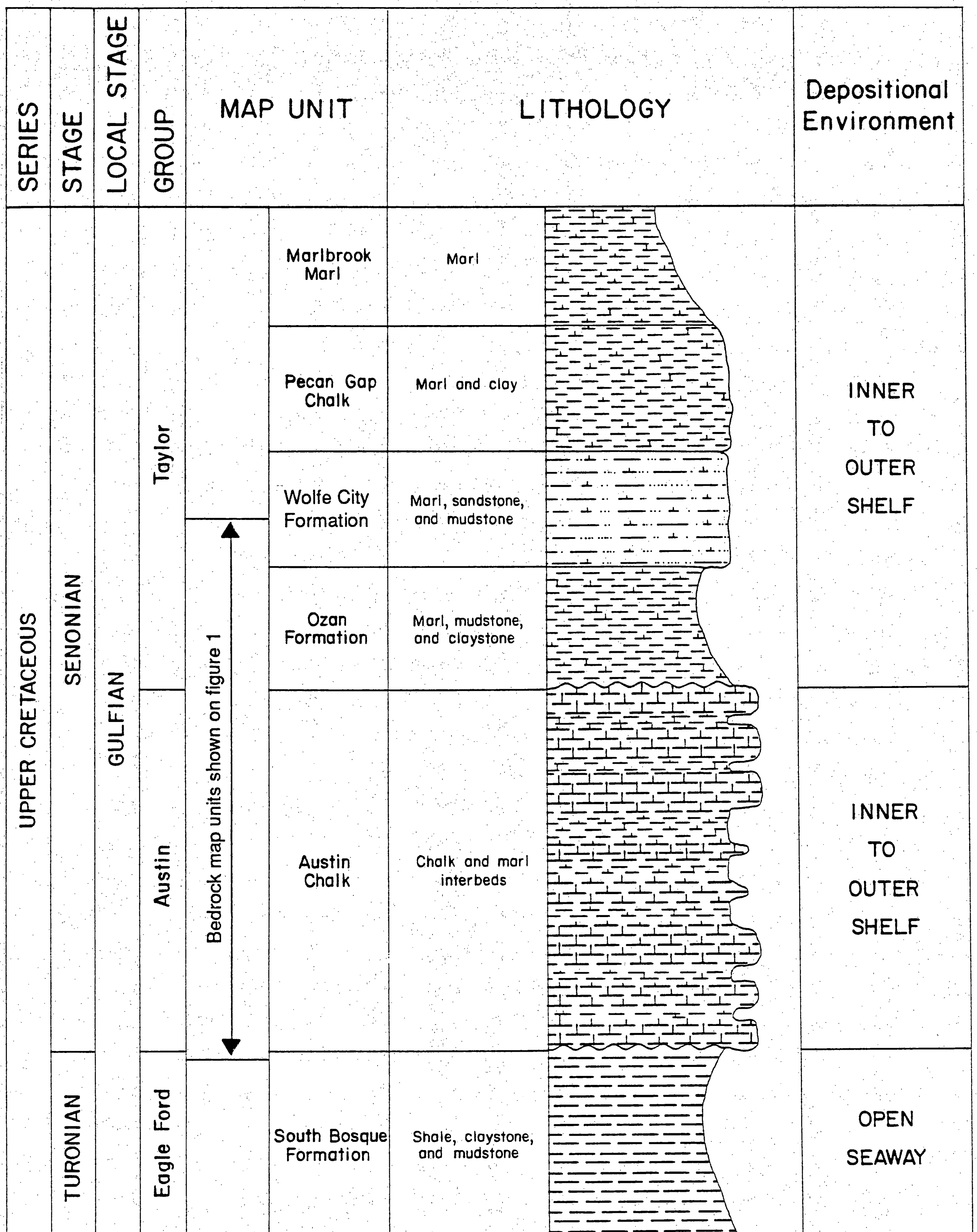

Figure 2. Stratigraphic column for Cretaceous units in the vicinity of the SSC site (modified from Reaser and others, 1983).

Eagle Ford Shale

The uppermost unit of the Eagle Ford Group in this area is the South Bosque Formation (Figs. 1 & 2). This interval includes the "fishbeds" so named because they contain fossil fish bones and teeth. Two "fishbeds" have been recognized, one a terrigenous sandstone of possible fluvial origin and the other a marine limestone. The name Eagle Ford Shale is used for the South Bosque Formation in work for the SSC Project. Only the upper part of the Eagle Ford Shale has been intersected by borings for the SSC Project.

Fresh exposures of the Eagle Ford Shale consist primarily of fissile dark gray to black calcareous to noncalcareous blocky marine shale. Weathered exposures of the shale range from tan to brown because of oxidation of pyrite. The upper 30 to 50 ft (9 to 15 m) of the Eagle Ford Shale is a plastic shale rich in bentonite (4). Calcium carbonate content of this interval ranges from 2 to 8 percent. The upper bentonitic shale interval is underlain by silty calcareous shales containing 35 to 50 percent $CaCO_3$ interbedded locally with limestone flags 5 to 6 inches (13 to 15 cm) thick (4). Laterally persistent white to tan bentonite seams (2 to 5 inches [5 to 13 cm] thick) are common in the Eagle Ford Shale.

The Eagle Ford Shale is not exposed at the surface but is encountered in borings below the Austin Chalk in the western part of the project area. The maximum thickness in the vicinity of the site is about 250 ft (76 m). Borings in the SSC Project area have penetrated a maximum thickness of 106 ft (32 m) in the Eagle Ford Shale.

STRUCTURAL GEOLOGY

The SSC site is near the eastern margin of the Texas Craton in a thick, predominantly chalk and marl sequence. The sedimentary sequence is broken locally by faults of the Balcones Fault System. Most faults of the Balcones system in this area strike east-northeast and are dip-slip normal faults. Maximum displacement on individual faults in the project area is probably about 100 ft (30 m). Fault planes dip at about 70°. Faulting in the Balcones system is the result of tensional stresses. Movement along the Balcones Fault Zone occurred during the Miocene (10 to 20 million years ago) as a result of rapid deposition into the Gulf Basin. No movement along faults or evidence for new faults has been detected during modern times.

Joints are associated with faults of the Balcones system. Fractures in this area are generally fewer than in areas to the south because there are fewer faults and there is less displacement along faults in the Balcones system in this area. A regional study of lineaments (5) shows that relatively few lineaments are present in this area. Because fracture density is generally related to lineament density, it is estimated that fractures in this area are also relatively sparse. The low density of faults and joints in the SSC Project area is not expected to have a significantly adverse effect on the rock quality of the bedrock materials.

A seismic risk map (6) shows that this area is located in Zone 0, which is designated as a no-damage zone. Other studies (7) showed that the estimated ground acceleration is less than 4 units in this area.

SITE OPTIMIZATION

Approximately 70 percent of the SSC tunnel will be constructed in the Austin Chalk and 30 percent in the Taylor Marl. The campus area will be located within the outcrop area of the Austin Chalk. Interaction halls on the west side of the ring may extend into the Eagle Ford Shale, depending on final design. Surface structures and interaction halls on the east side of the ring will be constructed in the Taylor Marl.

The erosional irregularities of the Austin Chalk in the outcrop area, the strike and dip of the strata, and design limitations for the inclination of the plane of the tunnel are the most critical geologic factors for location of the SSC facility. Orientation and inclination of the plane of the SSC ring can be varied within the footprint to provide optimum placement of the facilities.

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