A Preliminary Report on the Pennsylvanian Canyon Carbonates in North Central Texas

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ABSTRACT

The Canyon Group comprises an alternating sequence of limestone and shale formations, with sandstone members being common in the shales. The entire succession is crudely cyclic. Within the thickest limestone formation, the Winchell, detailed petrographic studies have shown the existence of regular vertical changes in texture. Three textural units occur, each commencing with arenitic textures at the base and grading upward to lutitic textures in the upper portion. These have been traced over several units and are believed to be referrable to regular changes in the depositional interface of the Winchell Bank with respect to energy base.

The Pennsylvanian System in the Brazos River valley of North Central Texas has been subdivided by earlier workers into three lithostratigraphic units. In ascending order they are the Strawn Group, the Canyon Group, and the Cisco Group. The rocks in this interval are represented generally by the rock units present in the Desmoines, Missouri and Virgil Series of the standard mid-continent section. The Canyon Group is distinguished by well developed limestone formations, in contrast to the subjacent Strawn and the superjacent Cisco Groups, which are composed predominantly of terrigenous clastics. The limestones of the Canyon Group, which are the subject of this paper, have been mapped in detail by Laury (1962), Feray and Brooks (1966), Wermund (1966), Kimball (in progress) and the authors throughout the type and adjacent areas of the Group in the Brazos River valley (Figure 1). This mapping forms the basis for the present detailed petrologic study. The preliminary results of this study are summarized in this paper. Here we have attempted to outline what we believe to be a likely environment for the deposition of these carbonates and we hope that this interpretation will provide a suitable framework for more detailed studies presently underway.

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The four major limestone formations in the Canyon Group are, in ascending order, the Palo Pinto, Winchell, Ranger and Home Creek. These are separated by intervening shale formations (several tens to a few hundred feet in thickness) in which sandstone bodies are well developed locally. The latter vary from a few feet to a few tens of feet in thickness. The limestones and sandstones are lenticular and commonly give way rapidly laterally to shale. Because the Win-

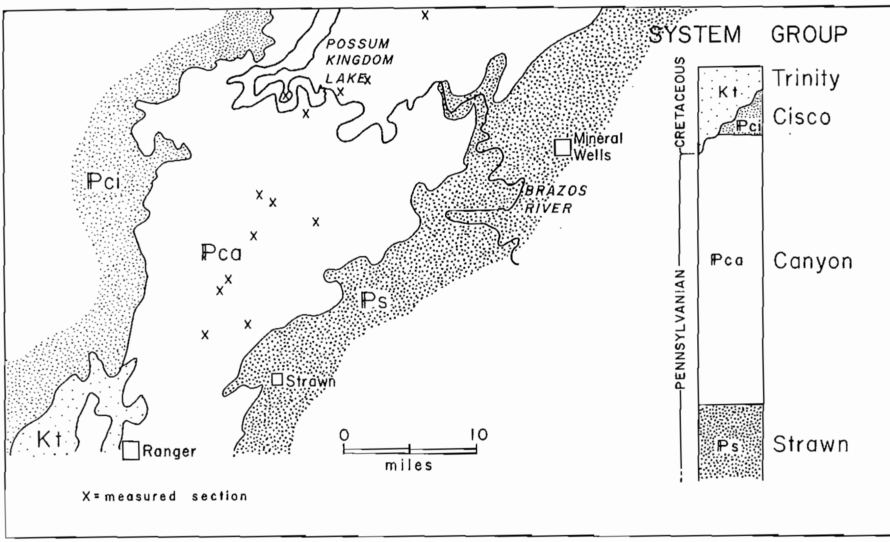

Figure 1—Index and Generalized Geologic Map

chell Limestone is the thickest and best exposed of the four limestone formations, it was chosen as the formation on which to begin the present study of the Canyon carbonate petrology. Ultimately it is our plan to examine in similar fashion the other limestone formations of the Canyon.

The Winchell has thus far been studied by detailed mapping and in a series of measured sections along a line generally parallel to the strike of the formation. Additional sections were studied in canyons approximately normal to the strike. Samples were collected at a maximum vertical spacing of five feet and studied in thin and polished sections. Spot samples augmented the prescribed geographic and vertical control. The distribution and thickness of the Winchell demonstrate that it is broadly lenticular. In the area studied the Winchell varies from about 50 feet in thickness to 160 feet in thickness. While in composition it is nearly pure calcium carbonate, its gross petrology indicates that it is composed primarily of comminuted skeletal fragments. Careful study demonstrates that the Winchell

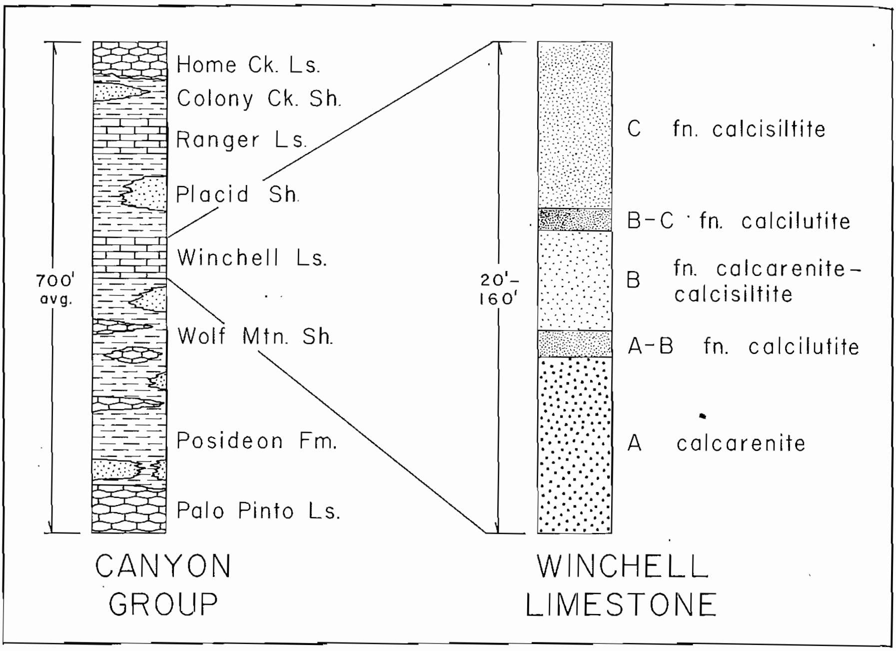

Figure 2—Columnar Sections, Canyon Group and Winchell Limestone

contains several lithologies which may be distinguished on the basis of texture. They vary from calcarenites to calcilutites.[1] On this textural basis the Winchell Limestone is divisible vertically into three main units. These units we have called, in ascending order, Winchell A, Winchell B and Winchell C (Figure 2). Winchell A is composed of poorly sorted, fusulinid and algal-rich skeletal calcarenites[2] and

[1] By necessity a slightly altered Wentworth scale was used in these measurements, but the accepted division between silt and sand (0.06 mm) has been retained. Further limits employed are as follows: coarse sand (0.60 mm - 2.00 mm), medium sand (0.20 mm - 0.60 mm), fine sand (0.06 mm - 0.20 mm), coarse-medium silt (0.02 mm - 0.06 mm), fine silt (0.01 mm - 0.02 mm) and clay (less than 0.01 mm).

[2] The classification of carbonate rocks is based entirely on size and amount of constituent particles. *Calcilutite*—A rock composed almost entirely of clay size particles (i.e. 90 per cent less than 10 microns), and may be referred to as microcrystalline. *Calcisiltite*—A rock composed almost entirely of silt size particles (i.e. 90 per cent less than 60 microns), and may be referred to as microclastic. *Calcarenitic (modifier) limestone*—Essentially a microclastic but containing up to 50 per cent sand size particles (0.06 mm - 2.00 mm). *(Modifier) calcarenitic limestone*—A rock composed of greater than 50 per cent, but less than 90 per cent sand grains. *Calcarenite*—A rock composed of greater than 90 per cent sand grains.

Specific adjective modifiers (e.g. skeletal, fusulinid, pelletal) may be added in the latter three categories. The classification is essentially that of Leighton and Pendexter (1962, A.A.P.G. Mem. 1, p. 45), but the various usages of the term micritic limestone have been supplanted by calcilutite, calcisiltite and calcarenitic limestone.

lenses of quartz sandstone. The average size of the larger fraction is medium to coarse sand. Silt and clay size particles constitute less than 30 per cent of the total. Winchell B is typically composed of skeletal calcisiltite and calcarenitic skeletal-algal limestone. The size of the identifiable fraction is fine sand and medium to coarse silt. Winchell C is predominately a fine-grained calcisiltite and calcilutite; only minor amounts of sand-size material appear in this otherwise homogeneous sequence. The horizons between units A and B, and B and C, are marked by thin but widespread and uniform calcilutites. These represent rapid vertical gradations to and from coarser limestones. Considerable lateral variation does exist within these three major units, but the general aspect of each is uniform. The variation is in the form of local lenses, typically of much coarser material. The entire Winchell Limestone shows a general tendency toward a decrease in particle size through time. Within this broad pattern one can recognize two distinct horizons at which there is a sudden decrease in size. These are the horizons separating A, B, and C (Figure 2). The base of Unit C, although generally composed of finer fragments than A or B, is still coarser grained than the horizon that separates B and C. The upper parts of C, however, look a good deal like the separating horizons. The fragmental nature of most of the particles in the Winchell may be attributed to comminution by physical agents, by organisms, or probably by both.

The evidence for comminution by physical agents is the widespread uniformity of particle size at various horizons within the Winchell, and the progressive change in particle size through time. Both of these characteristics suggest a direct relationship between current and wave energy base and the depositional interface. On the other hand there are present in the formation the fossil remains of various organisms whose present day descendants are known to comminute sediment by burrowing or boring. In addition, well preserved fossil bored surfaces are common in Canyon limestones. Thus we believe that both physical and biologic agents have participated in the process of particle fragmentation and size reduction. In the absence of clear evidence to indicate a unique agent of comminution the question remains an open one. However, the evidence strongly suggests that the particles, after comminution, have been reworked and distributed by physical agents. The widespread continuity of these beds laterally, the uniformity of size and shape sorting within each unit, the angularity of fragments in many of the layers, and the presence of superficial oolites tend to support this view. The coarse fragmental lenses referred to above may represent calcarenitic mounds or banks flanked by slightly less agitated water, since they grade laterally into finer grained material. These silts and muds, then, could represent debris that has been winnowed off of the banks by moderate current activity which thereby effected the greater concentration of coarse fragments on the more elevated areas. Finer sediments do exist regionally downdip, suggesting that energy base was above the depositional interface in this direction and that resulting bottom conditions may have been quieter, thus allowing the accumulation of finer sediments. Similarly, the upper parts of the Winchell Limestone grade into marls and mudstones of the overlying Placid Shale. It appears that the uppermost Winchell and the basal portions of the overlying Placid may also represent a regional deepening of the bottom with respect to energy base. The regular and widespread layers of finer particles that separate Winchell A, Winchell B, and Winchell C are believed to represent small-scale fluctuations in regional energy base which may be attributable either to variations in mean sea level or to shallowing of energy base as a result of prolonged calms. The first choice is regarded as likely because of the well established energy base fluctuations of Pennsylvanian time throughout much of the mid-continent and eastern interior areas. It is thus concluded that the carbonates of the Winchell were deposited as comminuted shell fragments on a shallow sea floor over which currents and waves were working fairly continuously. Small periodic changes (in time and space) in energy base placed the depositional interface in a lower energy environment for short periods thus permitting the deposition of finer particles.

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