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K-Ar AGE OF A VOLCANIC ASH BED IN THE QUARTERMASTER AND DEWEY LAKE FORMATIONS (LATE PERMIAN), TEXAS PANHANDLE

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The Quartermaster (outcrop) and Dewey Lake (subsurface) Formations are laterally equivalent Permian redbed sequences in West Texas. They are generally considered Late Permian (Ochoan) in age, but the possibility of an Early-to-Middle Triassic age has also been raised. A Triassic age is suggested by some cases of local stratal concordance with the overlying Dockum Group, which is dated as Late Triassic based on continental biostratigraphic zonation. However, the determination of age must be based on paleontologic or isotopic data and not on stratal concordance. The Quartermaster-Dewey Lake succession and overlying Dockum Group may be locally concordant but nonetheless unconformable throughout their areal extent.

Two volcanic ash beds have recently been discovered in both outcrop and core in the Quartermaster-Dewey Lake succession in the Palo Duro Basin, Texas Panhandle (fig. 1). The lower ash bed ranges in stratigraphic position from 4–20 m (13–66 ft) above the base of the Quartermaster-Dewey Lake sequence. K-Ar dates of 251 ± 4 and 261 ± 9 m.y. have been obtained for this bed. Both values are well in the range of Late Permian ages. The upper ash

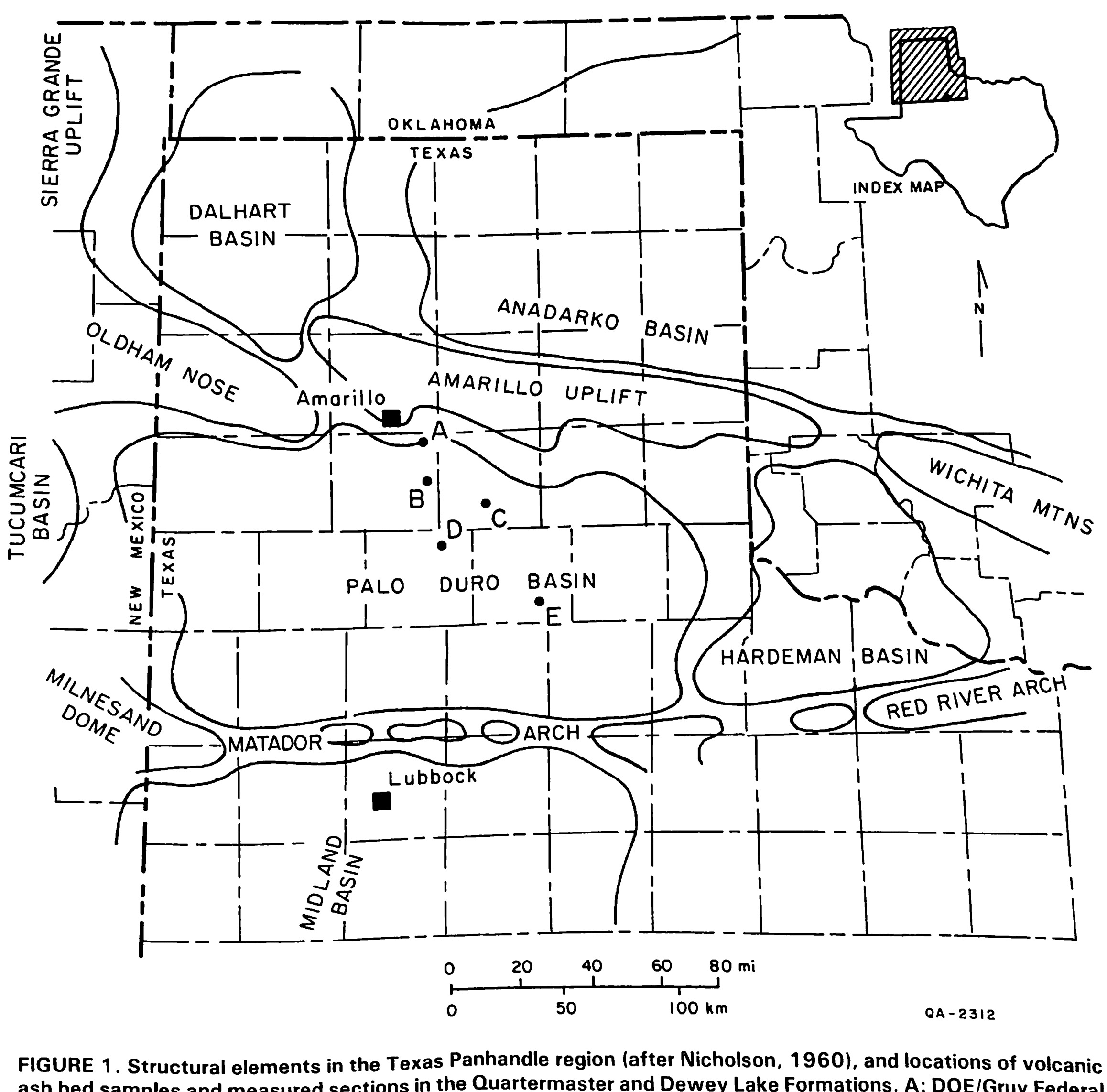

FIGURE 1. Structural elements in the Texas Panhandle region (after Nicholson, 1960), and locations of volcanic ash bed samples and measured sections in the Quartermaster and Dewey Lake Formations. A: DOE/Gruy Federal Rex White #1; B: Palo Duro Canyon State Park (PD-2); C: Texas Highway 207/117 crossing lower Palo Duro Canyon (PD-1); D: DOE/Gruy Federal Grabbe #1 (S-915); E: Caprock Canyons State Park (072982).

bed has not been dated. The contact between the Quartermaster-Dewey Lake and Dockum sequences varies from concordant to discordant at the locations of volcanic ash sample sites and measured sections.

SAMPLE PETROLOGY AND ANALYTICAL PROCEDURES

The lower volcanic ash bed is present in all examined localities. It varies in thickness from approximately 1.3–20 cm, but is generally 7–10 cm thick. It is cross-laminated in both outcrop and core samples. The upper volcanic ash bed is discontinuous and displays no internal primary structures in outcrop or core. In the Department of Energy/Gruy Federal Grabbe #1 core, the upper ash bed is present as a concentration of millimeter-sized clasts dispersed in a 5-cm-thick intraclastic zone, which implies local reworking after partial induration.

The mineralogy and texture of the lower volcanic ash bed is the same in each sampled occurrence, including Palo Duro Canyon State Park (sample PD-2; 34°57′58″N, 101°40′39″W; Randall County, Texas), lower Palo Duro Canyon (sample PD-1; 34°50′8″N, 101°24′44″W; Armstrong County, Texas), Caprock Canyons State Park (sample 072982; 34°24′52″N, 101°5′51″W; Briscoe County, Texas) and in the Grabbe #1 core (sample S-915; 34°39′44″N, 101°37′55″W; Swisher County, Texas). Both volcanic ash beds were also observed in the DOE/Gruy Federal Rex White #1 core (35°6′21″N, 101°41′53″W; Randall County, Texas), but they were not sampled because of insufficient material. Each sample contains varying amounts of subhedral to euhedral phenocrysts in a well-crystallized clay matrix having no distinct outlines of relict shards. Locally, the orientation of clay grains is highly random and may be inherited from devitrified shards. Phenocrysts include sanidine, quartz, biotite, and minor amounts of apatite, zircon, and Fe-Ti oxide. A large proportion of sanidine grains are hollow, possibly due to diagenesis. Some quartz grains are embayed. The presence of euhedral biotite and apatite indicates that transport has been minimal. The upper volcanic ash at Caprock Canyons State Park contains plagioclase in addition to sanidine, and has a larger ratio of phenocrysts-to-matrix than the lower volcanic ash beds. The phenocrysts are coarser grained, and hollow sanidine is less common in the upper volcanic ash.

The matrix of the lower volcanic ash bed at each sample locality consists of non-expansive clay with a 10 Å basal spacing, indicating probable illite (fig. 2). A minor amount of expansive clay (smectite) that was probably derived from alteration of illite is present in sample PD-2 (Palo Duro

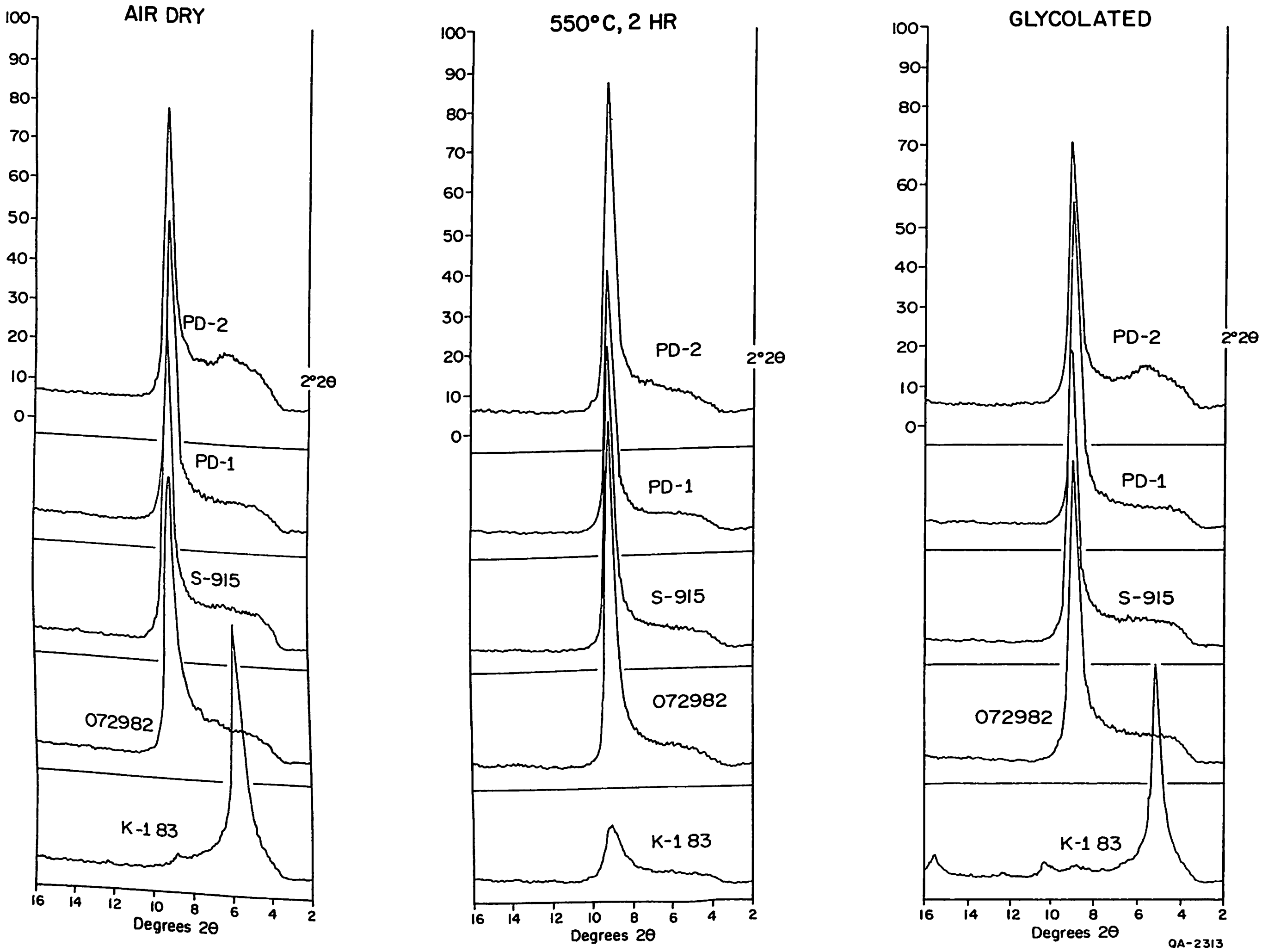

FIGURE 2. Results of clay mineral analyses of lower volcanic ash bed, Quartermaster and Dewey Lake Formations, Texas Panhandle.

Canyon). The upper volcanic ash bed at Caprock Canyons State Park contains only expansive clay (smectite), exhibiting basal spacings of 15.5 Å after air drying, 17.1 Å after glycolation, and 9.8 Å after collapse upon heating to 550°C for 2 hours (fig. 2).

Constants used in the age calculations are: $\lambda_\epsilon = 0.581 \times 10^{-10}$/yr; $\lambda_\beta = 4.963 \times 10^{-10}$/yr; $K^{40}/K = 1.167 \times 10^{-4}$ mol/mol.

RESULTS

K-Ar determinations using biotite in ash beds at Caprock Canyons State Park (2 determinations) and in the Grabbe #1 core give Late Permian ages ranging from 261 ± 9 to 251 ± 4 m.y. All ages are within the range of overlap of experimental errors. K-Ar ages of 251 ± 4 and 257 ± 9 m.y. were determined by different labs for 2 splits of a 785 mg concentrate of biotite from Caprock Canyons State Park. Only 110 mg of biotite were separated from tuffaceous rock in the Grabbe #1 core. The total amount of biotite was limited by its lower overall abundance in the core and the small volume of core available for processing. Duplicate analyses of potassium and radiogenic $argon^{40}$ were performed on this material, but the second $argon^{40}$ analysis is considered less reliable due to a malfunction in an induction furnace used to reduce contamination by atmospheric $argon^{40}$. The proportion of radiogenic $argon^{40}$/atmospheric $argon^{40}$ is only 0.178 in this analysis, compared to 0.718 to 0.850 for previous determinations. Due to the small sample size, no biotite concentrate was left to repeat the second $argon^{40}$ analysis for sample S-915. Using the first $argon^{40}$ determination gives an age of 261 ± 9 m.y.; an age of 271 ± 9 m.y. is obtained if an average of the two $argon^{40}$ analyses is used. Results of electron microprobe analysis of sample S-915 are shown in table 1.

TABLE 1. Results of microprobe analysis* in weight percent of sample S-915, DOE/Gruy Federal Grabbe #1 core, Swisher County, Texas.

Analysis			Ions per 24 (O,OH,F)	
SiO_2	38.77		Si	5.844
TiO_2	3.84		Ti	0.436
Al_2O_3	13.15		Al	2.337
FeO	13.99		Fe	1.765
MgO	14.44		Mg	3.243
Na_2O	0.47		Na	0.139
K_2O	8.90	(K = 7.39%)	K	1.711
OH	3.97		OH	2.000
TOTAL	97.53		TOTAL	17.475

*Average of 10 analyses on 5 grains.

The consistent stratigraphic position, similarity in mineralogy and texture, and agreement, within experimental error, of K-Ar ages indicate that the lower volcanic ash bed observed in all the localities is correlative and represents a unique event. Correlation of the upper volcanic ash beds is questionable because of their lesser thickness and sporadic distribution.

ACKNOWLEDGMENTS

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SAMPLE DESCRIPTIONS

D. *S-915* K-Ar

Volcanic ash (34°39'44"N, 101°37'55"W; DOE/Gruy Federal Grabbe #1 core, Swisher Co., TX). *Analytical data:* Sample weight = 110 mg; K = 7.329, 7.393%; $*Ar^{40}$ = 0.1435, 0.1552 ppm; $*Ar^{40}/\Sigma Ar^{40}$ = 0.718, 0.175. *Comments:* Results of the second $argon^{40}$ analysis are less reliable due to incomplete sample decontamination. No biotite concentrate was left to repeat the analysis.

(biotite)261 ± 9 m.y.

E. *072982* K-Ar

Volcanic ash (34°24'52"N, 101°5'51"W; Caprock Canyons State Park, Briscoe Co., TX). *Analytical data:* Sample weight (split 1) = 590 mg; K = 7.434, 7.383%; $*Ar^{40}$ = 0.1438, 0.1402 ppm; $*Ar^{40}/\Sigma Ar^{40}$ = 0.823, 0.850. Sample weight (split 2) = 195 mg; K = 7.542%; $*Ar^{40}$ = 0.1406 ppm; $*Ar^{40}/\Sigma Ar^{40}$ = 79%.

split 1 (biotite)257 ± 9 m.y.
split 2 (biotite)251 ± 4 m.y.

REFERENCE

Nicholson, J. H. (1960) Geology of the Texas Panhandle, *in* Aspects of the geology of Texas, a symposium: University of Texas, Austin, Bureau of Economic Geology Publication 6017, p. 51–64.

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