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Ashfall Tephra in the Ogallala Group of the Great Plains: Characteristics and Significance

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ABSTRACT. The Miocene Ogallala Group blankets the Great Plains east of the Rocky Mountains. This sheet of largely fluvial deposits, lying downwind of major silicic volcanic fields to the west, was ideally located to receive and preserve tephra from these fields. This investigation brings modern methods of tephrochronlogy to bear on the age and identity of Ogallala tephra. Results indicate that ~40 separate tephra layers, ranging in age from ~16.5–5.0 Ma, in the Ogallala. Most tephra came from Yellowstone hotspot sources. The relative frequency of hotspot tephra in the Ogallala matches that in more proximal regions to the west with peak intensities in the intervals ~16.5–15 Ma nd ~13.0–8.5 Ma. About 30 of the Ogallala tephra are correlated with tephra of known age the the Basin and Range to the west. Using the ages of correlative tephra to the west insight into the age of the Ogallala, the correlation of Ogallala tephra from region to region in the Great Plains, and sedimentation rates within the Ogallala. In the Ogallala sedimentation rates vary. The rates are lowest (3–9 m/Ma) in the Cap Rock Mbr. of the Ash Hollow Fm. along the Niobrara River and in undifferentiated Ogallala strata and in the undifferentiated Ogalala Gp. in NW Kansas. Rates of 40–80 m/Ma characterize the Valentine Fm. beneath the Cap Rock Mbr. Finally, one tephra, the 11.37 Ma Cougar Point Tuff XI, is recognized at 6 localies. This key horizon provides the first detailed structure contours within the Ogallala. These contours show a sharply increasing slope of the Ogallala west of 101˚ W that reflects the post–6 Ma tilt along the western edge of the Ogallala. East of 101° W the gradients mirror the gradients of the major rivers (1.3 to 1.6 m/km.). West of 101° W gradients increase and reach a maximun of 4.6 m/km at the crest of the Gangplank.

Profiles and Sample Location Maps

Sample Locations and Contours. Red crosses mark localities of tephra with associated ID's or names of the tephra. The numbered star symbols along the Niobrara River and its tributaries mark the locations of the measured sections of Skinner and Johnson (1984). The profile is based, in simplified form, on these sections. The curved green lines are the best fit contours on the base on the Cougar Point Tuff unit XI.

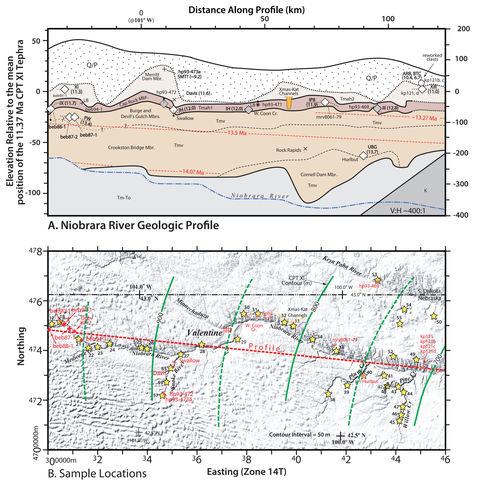

Figure 1: Niobrara River Area. The Niobrara River profile is shown in **A** and the geographic location of the profile is shown in **B**. The datum for this profile is the 11.37 Ma Cougar Point Tuff unit XI of Bonnichsen and Citron (1982). Geologic units along the the profile are, from base upwards: **Kp - Pierre Shale**; Tm-To - undifferentiated Oligocene and Miocene units; **Tmv Valentine Fm.** with four members - the Cornell Dam, Crookston Bridge, Devil's Gulch, and Burge Members - from base to top; and, finally , the **Ash Hollow Fm.** which is divided into two members - the Cap Rock and the Merritt Dam Members which are labeled Tmah1 and Tmah2 on the profile.

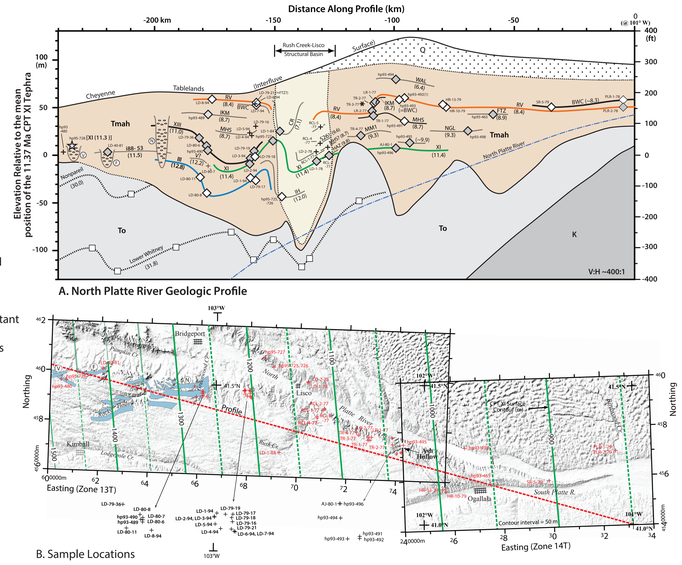

Figure 2: Platte River Area Profile. The Platte River profile is shown in **A** with the location of the profile shown in **B**. More generally, profile locations are shown in distribution map of the Ogallala Group below. Abbreviations of named tephra are shown on the profile. Sample numbers are given next to the diamond symbols in regular font and the abbreviation of named tephra and their ages are shown along the tie lines connecting such tephra. The full tephra names are listed in the correlation chart below. Three channels, identified by the circled letters **"V" "F"** and **"N"** cut deeply through older Ogallala. Finally, It's important to note that tie lines connecting individual locations of a given tephra are for illustrative purposes only. In these alluvial deposits most of the tephra layers were incised by younger channels cutting through an originally continuous tephra layers.

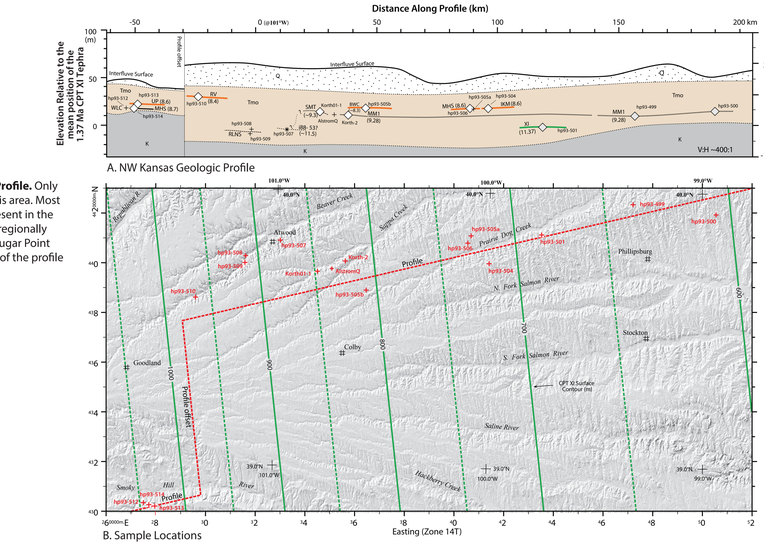

Figure 3: Northwest Kansas Area Profile. Only limited sample collection done in this area. Most of the tephra in this area are also present in the areas to the north. In particular, the regionally distributed reference layer of the Cougar Point Tuff XI is in this area. Note the offset of the profile line.

Figure 4. Locations of geologic profiles, Structural Contours, and boreholes within the Ogallala Group.

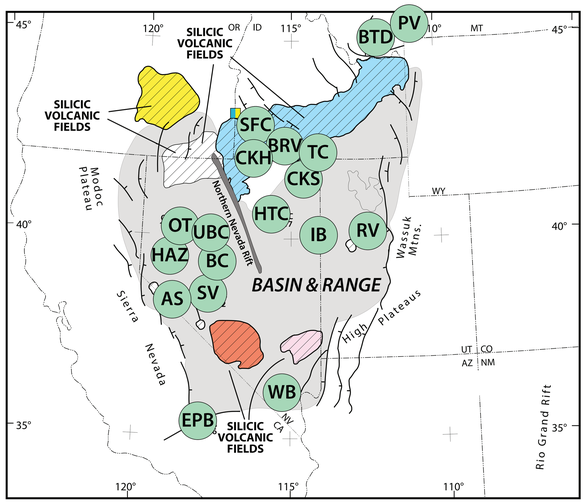

Figure 5. Location of tephra-rich sections in the Basin and Range. This sections are shown to the right in Figure 6.

Tephra Name	*EventID*	*EventAge*	*Type*
clk93-35	clk93-35	6.38	dac
clk93-34	clk93-34	6.40	dac
clk93-32	clk93-32	6.43	dac
clk93-31	clk93-31	6.45	dac
clk93-30	clk93-30	6.46	wm
Blactail Deer Cr.	BTC	6.69	gm
clk93-18	clk93-18	6.76	dac
clk93-14	clk93-14	6.86	dac
clk93-13	clk93-13	6.91	o
clk93-12	clk93-12	6.94	dac
Cub River	CR	7.08	gm
Rattlesnake	RAT	7.12	o
clk93-06	clk93-06	7.31	dac
clk93-05	clk93-05	7.41	wm
Faust	FST	7.57	gm
Shoofly Cr.	SFC	7.62	per
clk93-02	clk93-02	8.12	gm
Birdwood Cr.	BWC	8.30	gm
Rush Valley	RV	8.39	gm
epb92-81	epb92-81	8.50	dac
Inkom	IKM	8.58	gm
Union Pacific	UP	8.59	o
McMullen Cr. 4?	MM4?	8.67	gm
Murphy Hotsprings	MHS	8.70	gm
McMullen Cr. 2?	MM2?	8.96	gm
Feltz Ranch	FTZ	9.23	gm
McMullen Cr. 1	MM1	9.28	gm
Nightingale	NGL	9.33	gm
Sheep Dip	SD	9.45	wm
tc90-23	tc90-23	9.50	gm
Opal Canyon 6	OC6	9.60	gm
Section 26	S26	9.67	gm
Celetron 2	CEL2	9.69	wm
qg-oa	qg-oa	9.79	dac
Hazen	HAZ	9.82	gm
Wooden Shoe Butte	WSB	10.21	gm
Opal Canyon 3	OC3	10.24	gm
tc90-18	tc90-18	10.32	gm
tc96-933	tc96-933	10.45	gm
i88-67	i88-67	10.54	gm
Cougar Point Tuff XVj	XVj	10.58	gm
Tuff of Steer Basin	STB	10.63	gm
Opal Canyon 2	OC2	10.68	gm
Ibex Peak 19	IP19	10.85	gm
Cougar Point Tuff XIII	XIII	11.03	gm
Basalt	Basalt	11.13	ba
Cougar Point Tuff XII	XII	11.23	gm
Cougar Point Tuff XI	XI	11.37	gm
i88-53	i88-53	11.50	gm
Coal Valley	CV	11.54	gm
Ammonia Tanks	AT	11.61	gm
Brown's Hill	BH	11.69	gm
Cougar Point Tuff IX	IX	11.71	gm
Rainier Mesa	RM	11.76	wm
Middle Creek	MDC	11.83	gm
Overnight	OVN	11.86	wm
Ibex Peak 8	IP8	11.88	gm
Ibex Hollow	IH	12.03	gm
Aldrich Hill 2	AH2	12.18	gm
Cougar Point Tuff V	V	12.23	gm
Aldrich Hill 1	AH1	12.23	gm
White Basin	WB	12.24	gm
Banded	BND	12.44	gm
Petroglyph	PTG	12.54	gm
Cougar Point Tuff III	III	12.83	gm
Grant Claim	GRTC	13.06	gm
Ibapah Badlands	IBL	13.07	wm
Pojoaque White	PW	13.49	wm
Upper Blue-Gray	UBG	13.65	gm
Rawhide Ranch	RWR	13.85	gm
Grouse Creek?	GRC?	13.96	gm
Violet's Hollow 3	VH3	13.99	gm
Cedar Gulch 8	CG8	14.24	gm
Lower Blue-Gray	LBG	14.24	gm
Shimek	SMK	14.31	gm
htc93-445	htc93-445	14.66	gm
Obliterator	OBL	14.84	gm
Paradise Valley 2	PV2	15.05	gm
Twin Bridges 2	TB2	15.10	gm
Huntington Cr. 2	HTC2	15.14	gm
Tesuque White 4	TW4	15.17	wm
buf94-615	buf94-615	15.17	gm
Antonne Wash	AW	15.19	gm
buf94-611	buf94-611	15.35	gm
Paradise Valley 1	PV	15.37	gm
Virgin Valley 12	VV12	15.38	gm
buf94-606	buf94-606	15.50	gm
Huntington Cr. 1	HTC1	15.53	gm
Virgin Valley 4	VV4	15.60	gm
Sheep Creek 3	SC3	15.93	bc
Tesuque White 1	T1W	16.05	wm

Comments on Tephra Correlations. *In this study tephra correlations are based on the geochemistry of glass shards and relative stratigraphic position. The chemical analyses were done by electron probe microanalysis (EPMA) and by X-ray fluoresence (XRF) at the department of Geology and Geophysics at the University of Utah (UU) under the directions of Dr. Barbara Nash (EPMA) and Dr. Francis Brown (XRF). The geolgic section measurements, sample collection, and sample preparations in the Basin and Range were done by Michael Perkins. Similar work was done by Steve Williams in the Chalk Hills Fm. along the southern edge of the Snake River Plain [Chalk Hills location (CKH) and Shoofly Creek (SFC) location].*

Figure 6. Basin and Range to Great Plains Tephra Correlations

Tephra Name	*EventID*	*EventAge*	*Type*
clk93-35	clk93-35	6.38	dac
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