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AGE AND EFFECTS OF THE ODESSA METEORITE IMPACT, WESTERN TEXAS, U.S.A. Vance T. Holliday, David A. Kring, James H. Mayer, and Ronald J. Goble

DATA REPOSITORY – APPENDIX 1: METHODS

Field work consisted of examining exposures left by the 1939-1941 trenching on the margins of the main crater and recovery of cores through the center of the crater fill. The primary exposure of the thickest crater fill was the shaft sunk through to bedrock, but it is not accessible and no detailed description exists. Likewise, no logs or samples from the coring remain. We took 6 cores, 1" to 3" diameter in 2001, 2003, and 2004, using a CME coring rig (2001) to 22 m, a Giddings probe (2003) to 9 m, and a GeoProbe (2004) to 15 m, all yielding 95% recovery. Each was within 10 m north and northeast of the old shaft. The cores plus a stratigraphic section for part of the old shaft (Evans and Mear, 2000, fig. 29) provide two stratigraphic records (Fig. 1; Table DR1).

Laboratory work entailed basic soil and sediment characterization (Table DR2), and dating. Samples were analyzed for particle-size distribution, and organic-carbon and calcium carbonate content. Dating was carried out using optically-stimulated luminescence (OSL) on deeper silty sediments and radiocarbon for organic-rich mud in the upper fill above the silt (Tables DR3, DR4). Four radiocarbon ages were determined on soil organic matter (SOM) extracted from decalcified sediment. OSL dating determines the time since sediment was last exposed to light (i.e., the burial age). A two-second sunlight exposure will reduce the signal from quartz by a factor of 10 (Godfrey-Smith et al. 1998). Seven OSL ages were determined (following Rittenour et al., 2003) on a Riso TL(thermoluminescence) /OSL-DA-15B/C reader with blue-green light stimulation, using the Single Aliquot Regenerative (SAR) technique (Murray and Wintle, 2000). A dose-recovery test (Murray and Wintle, 2003) recovered 71.81

+/-1.25 ka from a dose of 73.32 ka applied to UNL714; thermal transfer for UNL714 was 0.16+/-0.10 ka. Growth curves were well below saturation. With the exception of UNL960, optical ages are based upon a minimum of 20 aliquots. Individual aliquots were monitored for insufficient count-rate, poor quality fits (i.e. large error in the equivalent dose, D_e), poor recycling ratio, dominant medium in comparison to fast component, presence of an ultrafast component, and detectable feldspar. Dose-rates were calculated on U, Th, and K (Table DR3) following Adamiec and Atiken (1998). Cosmic contributions were calculated after Prescott and Hutton (1994).

Table DR1. Field description of cores from the Odessa Meteorite Crater.

Cores 01/04[1]

Unit	*Thickness, m*	*Description*[2]
Gray Mud	0.0-3.30	Dark gray brown to dark brown (10YR 3/2, 4/2) silt loam; medium angular blocky ped structure; common carbonate films & threads on ped faces; lens of carbonate gravel @ 2.00 m; sand & gravel @ 2.75-3.30 m.
	3.30-6.40	Brown (10YR 5/3) silt loam; weak platy to fine angular blocky ped structure; common carbonate films & threads on ped faces; fine Mn nodules common;
Yellow Silt	6.40-8.85	Yellowish brown (10YR 5/8) silt loam; Btk soil horizon; prismatic & subangular blocky ped structure; thin, common clay films, common films & threads of $CaCO_3$ and common Mn patches on ped faces.
	8.85-9.50	Brownish yellow (10YR 6/6) silt loam to clay loam; Bk soil horizon; silt loam; subangular blocky ped structure; common films & threads of $CaCO_3$ on ped faces
	9.50-18.75	Very pale brown (10YR 7/4) silt loam to clay loam; massive to weakly blocky ped structure; carbonate rock fragments common; lenses of rock rubble @ 11.00, 13.50, 14.50 m.
	18.75-20.75	Bedded silt & clay with lenses of rock rubble.

Core 03-5[3]

Gray Mud	0.0-0.5	Very dark gray (10YR 3/1) silt loam; medium angular blocky ped structure.

	0.5-1.00	Dark gray brown (10YR 4/2) silt loam; ABt soil horizon; prismatic & subangular blocky ped structure.
Yellow Silt	1.00-1.50	Light brown (7.5YR 6/3) silt loam; Btk soil horizon; prismatic & subangular blocky ped structure; thick continuous clay films & common films of $CaCO_3$ on ped faces; abrupt contact
	1.50-3.05	Brown (7.5YR 5/3) silt loam; Btkb1 soil horizon; prismatic & subangular blocky ped structure; darker continuous clay films & common films of $CaCO_3$ on ped faces; abrupt contact.
	3.05-4.50	Brown (7.5YR 5/4) silt loam; Btkb2 soil horizon; prismatic & subangular blocky ped structure; thick discontinuous clay films & common films of $CaCO_3$ on ped faces.
	4.50-7.70	Very pale brown (10YR 7/4) sandy loam; Bkb2 soil horizon; weakly platy soil structure; common films & threads of $CaCO_3$.
	7.70-9.50	Very pale brown (10YR 8/4) silt loam; massive to weak prismatic soil structure.

[1] 01/04 is a composite stratigraphic section of two cores taken 4 m apart and within 7 m north-northeast of old shaft through crater fill

[2] Colors are Munsell, dry.

[3] 03-5 was recovered ~12 m east of the old shaft.

Table DR2. Laboratory data for fill in the Odessa Meteorite Crater.

Zone	Depth, m	Sand %[1]	Silt %[1]	Clay %[1]	Texture[2]	O.C. %[3]	$CaCO_3$ %[4]
3 (Gray Mud)	1	8	70	22	silt loam	0.68	30
	5	14	73	13	silt loam	0.13	3
2 (Yellow Silt)	7[5]	20	71	9	silt loam	0.21	1
	11	34	42	24	loam	0.22	50
	17	13	55	32	silty clay loam	0.22	47

[1] Particle-size analysis following Janitzky (1986a).

[2] U.S. Department of Agriculture texture classification.

[3] O.C. = organic carbon, following Janitzky (1986b)

[4] Calcium carbonate equivalent, following Machette (1986).

[5] Sample collected at 7 m = Bt horizon of well-expressed soil formed in Zone 2, Core 01/04.

Table DR3. Results for OSL dating of Zone 2 (yellow silt) samples from the Odessa Meteorite Crater.

Sample	Depth	H_2O	K_2O	U	Th	Cosmic	Dose Rate	D_e	Recuperation	No. of	Age
UNL#	m	wt. %[1]	wt. %[2]	ppm[2]	ppm[2]	Gy	Gy/ka	Gy[2]	%	Aliquots	ka[4]
714[5]	4.7	6.7	1.54	1.8	6.2	0.13	2.08 ± 0.08	75.43 ± 2.89	0.6	20	36.33 ± 2.28
715[5]	5.6	7.7	1.52	2.0	6.7	0.12	2.10 ± 0.09	83.77 ± 3.34	0.6	20	39.86 ± 2.57
716[5]	7.9	6.3	0.90	2.6	4.9	0.09	1.67 ± 0.07	88.85 ± 3.21	0.8	24	53.15 ± 3.40
957[5]	12.3	4.3	0.90	2.4	5.8	0.06	1.73 ± 0.08	92.58 ± 3.32	0.8	29	53.74 ± 3.43
958[5]	12.5	5.2	0.84	2.9	5.6	0.06	1.77 ± 0.08	89.51 ± 3.30	0.8	20	50.89 ± 3.33
959[6]	15.8	9.8	0.47	3.5	7.0	0.05	1.61 ± 0.09	101.67 ± 3.51	1.0	35	63.46 ± 4.45
960[6]	15.9	10.0	0.47	3.7	7.3	0.05	1.67 ± 0.09	85.22 ± 9.38	1.2	10	51.30 ± 6.47
960[7]								96.97 ± 6.45		8	58.37 ± 5.28

[1] In situ moisture content determined by weight loss upon drying.

[2] Determined using ICP-AES and ICP-MS by Chemex Labs, Inc. using a 4-acid digestion.

[3] One standard error; Gy = Gray, a radiation dose of 1 J/kg

[4] Error on age is one standard error and includes random and systematic errors calculated in quadrature (Aitken, 1976).

[5] 90-150 μm grains.

[6] 90-250 μm grains.

[7] Two anomalously low De-values (32, 44 Gy) were omitted (see text for discussion).

Table DR4. Radiocarbon ages on playa mud in the main Odessa Meteorite Crater.

Lab Number	Depth, m	Age, yr B.P. (± one sigma)	Calibrated Age Range Cal yr B.P. (± one sigma)	$\delta^{13}C$
AA44164	1.5	7975±57	8988-8768	-6.12
AA44165	2.5	8888±61	10101-9914	-6.02
AA44166	3.7	11,287±71	13234-13114	-5.27
AA44167	6.3	10,426±83	12401-12149	-23.5

Table DR5. Calculated energy and seismic magnitude of the Odessa impact event and the area affected by impact-generated overpressures and air blast.

Estimated yield (kt)[1]		0.5	2	5	10	50
Seismic magnitude		2.4	2.8	3.1	3.3	3.8
Peak overpressure (psi)	Maximum wind velocity[2] (km/hr)	Radial distance from impact (m)	Radial distance from impact (m)	Radial distance from impact (m)	Radial distance from impact (m)	Radial distance from impact (m)
100	2280	80	130	180	230	380
50	1500	110	180	240	300	510
30	1080	140	230	310	390	670
20	810	170	270	370	470	800
10	470	250	390	540	670	1150
5	260	360	580	780	990	1680
2	110	620	980	1330	1680	2860
1	60	930	1470	2000	2520	4300
Moderate Damage						
Coniferous Forest		300	480	720	930	1680
Deciduous Forest		440	720	990	1270	2290
Severe Damage						
Coniferous Forest		230	380	550	730	1370
Deciduous Forest		320	550	780	1040	1750

[1] Estimated yield is the energy released at the impact site; additional energy was imparted to the atmosphere during descent.

[2] Wind velocities are calculated for an ambient atmospheric pressure at sea level. Distances rounded to nearest 10 m.

Table DR6. Impact cratering in the past 100 ka.

Crater Name	Diameter* (km)	Age (ka
Amguid	0.45	<100
Barringer	1.2	49 ± 3
Boxhole	0.17	54 ± 1.5
Campo del Cielo	0.05	<4
Haviland	0.015	<1
Henbury	0.157	42 ± 1.9
Kaalijärv	0.11	4 ± 1
Lonar	1.83	52 ± 6
Macha	0.3	<7
Morasko	0.1	<10
Odessa	0.168	~63.5 ± 4.5 (this study)
Rio Cuarto	~1	<100
Sikhote Alin	0.027	0.055
Sobolev	0.053	<1
Tenoumer	1.9	21.4 ± 9.7
Wabar	0.116	0.14

*In the case of crater fields, the diameter of the largest crater
Source: Earth Impact Database, 2003, http://www.unb.ca/passc/ImpactDatabase/ (Accessed: 14 July 2005)

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