PETROLOGICAL AND GEOCHEMICAL STUDIES OF SAMPLES FROM THE NICOR CHESTNUT 18-4 DRILL CORE, AMES IMPACT STRUCTURE, OKLAHOMA. Christian Koeberl[1] and Wolf Uwe Reimold[2]. [1]*Institute of Geochemistry, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria (a8631dab@vm.univie.ac.at);* [2]*Department of Geology, University of the Witwatersrand, Johannesburg 2050, South Africa (065wur@cosmos.wits.ac.za).*

Introduction and Summary. The near-circular 15-km-diameter Ames structure is located at 36° 15' N and 98° 12' W in southeastern Major County (NW Oklahoma). The structure, which is set in Cambro-Ordovician Arbuckle dolomite, consists of two concentric rims: an about 1.5 to 3 km wide outer rim, which is separated by an annular though from an inner "rim" (about 5 km in diameter). The rocks of the outer rim consist mainly of fractured and brecciated Arbuckle dolomite. The inner "ring" seems to be the eroded remnant of a central structural uplift, with rocks comprising brecciated Precambrian granite and Arbuckle dolomite. The depression is covered by Middle Ordovician Oil Creek shale. The structure is penetrated by a number of oil- and gas-producing wells in the crater rim and the central uplift. The production from these wells makes Ames one of the largest - if not the largest - oil fields in Oklahoma. Currently the structure is buried beneath almost 3000 m of sedimentary rock. The origin of the structure has been intensely debated since the discovery of the structural anomaly, but geophysical and geological [1,2], as well as petrological and geochemical [3,4] data provide definitive evidence that it was formed by impact, and not by volcanism [5] or even more esoteric processes [6]. In the present study, we analyzed 17 samples, including impact melt breccia, from the Nicor Chestnut 18-4 core. These samples represent the largest and best examples of impact melt breccias and melt rock obtained so far from the Ames structure. One important result of the petrographic analyses is the observation that not all carbonate rocks postdate the impact, but some were clearly present among the target rocks. The chemical composition of the impact melt breccias is similar to that of melt rocks from the Dorothy 1-19 core, as well as to the target granite, with variable carbonate admixtures. Some impact melt rocks are enriched in siderophile elements, indicating a possible meteoritic component.

Breccias, Impact Melts, Age, and Methods. In earlier work we reported on mineralogical, petrographical, and geochemical studies of a variety of samples from eight drill-cores from the Ames structure [3,4]. Samples from the Gammon 1-34, Dixon 2-18, Dorothy 1-19, and Bland 1-33 drill cores were found to contain numerous shocked quartz and feldspar grains, with up to three sets of shock-characteristic planar deformation features (PDFs), and some impact glass fragments [4]. Also, we found small fragments of fine-grained subophitic and aphanitic impact melt rocks in the Dorothy 1-19 drill core, with chemical compositions that are very similar to those of the target granite. Based on stratigraphic arguments, the age of the Ames structure was estimated at about 470 Ma, but ^{40}Ar-^{39}Ar incremental-release age dating of the impact melt rocks yielded plateau ages of about 285 Ma [4]. This latter age may either date the impact event or be the result of low-temperature thermal resetting event coinciding with the Nemaha Uplift. For the present work, we used optical microscopy, X-ray fluorescence analysis, and neutron activation analysis to study a set of 17 samples from the Nicor Chestnut 18-4 core, which was drilled to a depth of 2754.4 m in the northern part of the annular depression within the Ames structure.

Petrology and Geochemistry. Our drill core samples cover the depth range of 2744.0 to 2754.2 m (9002.6 to 9036.0 ft). The first few samples, to about 2744.4 m, consist of very fine-grained carbonate cut by thin quartz veinlets, or are composed of alternating mm-wide bands of fragmental breccia composed of carbonate and granite clasts set into a fine-grained clay mineral and carbonate-rich matrix, and fine-grained carbonate. The quartz and feldspar grains within the breccia contain abundant PDFs with multiple orientations (Fig. 1), and several melted clasts were found as well. These samples probably represent debris flows derived from underlying material alternating with post-impact carbonate. However, up to 5 mm wide carbonate fragments occurring as clasts within the breccia signify the existence of carbonate rocks among the pre-impact target stratigraphy as well. Samples from 2744.8 to 2746.6 m consist of fragmental impact breccia composed of both granite-derived and carbonate clasts. Carbonate occurs in the form of angular clasts and very fine-grained matrix, clearly representing two different generations. Samples from 2747.9 to 2754.2 m are impact melt breccia with a widely varying clast content (Fig. 2). Most clasts are granite-derived, but carbonate and schist clasts were observed as well. Some alteration is indicated by the presence of secondary carbonate. Sample 9017.6 (from 2748.6 m depth) is a near-aphanitic impact melt breccia with little evidence for devitrification, which is still glassy in places (Fig. 2b). Most clasts in these impact melt breccias are either fully annealed or contain abundant shocked minerals. The major and trace element composition of bulk samples of these impact melt rocks and impact melt breccias is very similar to that of average granitic basement (and also to that of melt rocks from the Dorothy 1-19 core, [4]), as shown in Table 1. The melt rocks have lower Na and higher K contents compared to the average granitic composition, which is common for impact melt rocks, and contain various amounts of carbonate. Compared to the low levels present in the target granites, several impact melt breccia samples have elevated contents of elements that indicate admixture of a meteoritic component (Cr, Co, Ni, Ir), with up to 2.2 ppb Ir in sample 9017.6.

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Table 1: Major element composition (XRF) of selected samples from the Ames structure.

Sample#	9189.1	9003.5	9015.5	9020.7	9027.6
Core:	1-33	1-19	18-4	18-4	18-4
	Granite	Melt	Melt	Melt	Melt
SiO_2	73.30	75.98	52.69	60.25	66.70
TiO_2	0.22	0.30	0.31	0.37	0.20
Al_2O_3	11.20	10.64	11.78	12.87	11.40
Fe_2O_3	1.43	0.54	1.63	1.67	0.86
MnO	0.051	0.016	0.103	0.071	0.030
MgO	0.85	0.40	5.82	3.76	1.91
CaO	1.75	0.59	8.01	4.10	3.05
K_2O	3.52	0.23	1.45	1.79	0.51
Na_2O	4.40	9.72	5.37	8.40	9.45
P_2O_5	0.024	0.033	0.10	0.10	0.03
L.O.I.	2.93	1.51	13.52	7.84	6.55
Total	99.68	99.96	100.78	101.22	100.69

Cores: Bland 1-33, Dorothy 1-19, Chestnut 18-4. Data in wt%.

Fig. 1. Quartz with 2 sets of PDFs, sample 9003.7 (Chestnut 18-4); 365 μm wide, crossed polars.

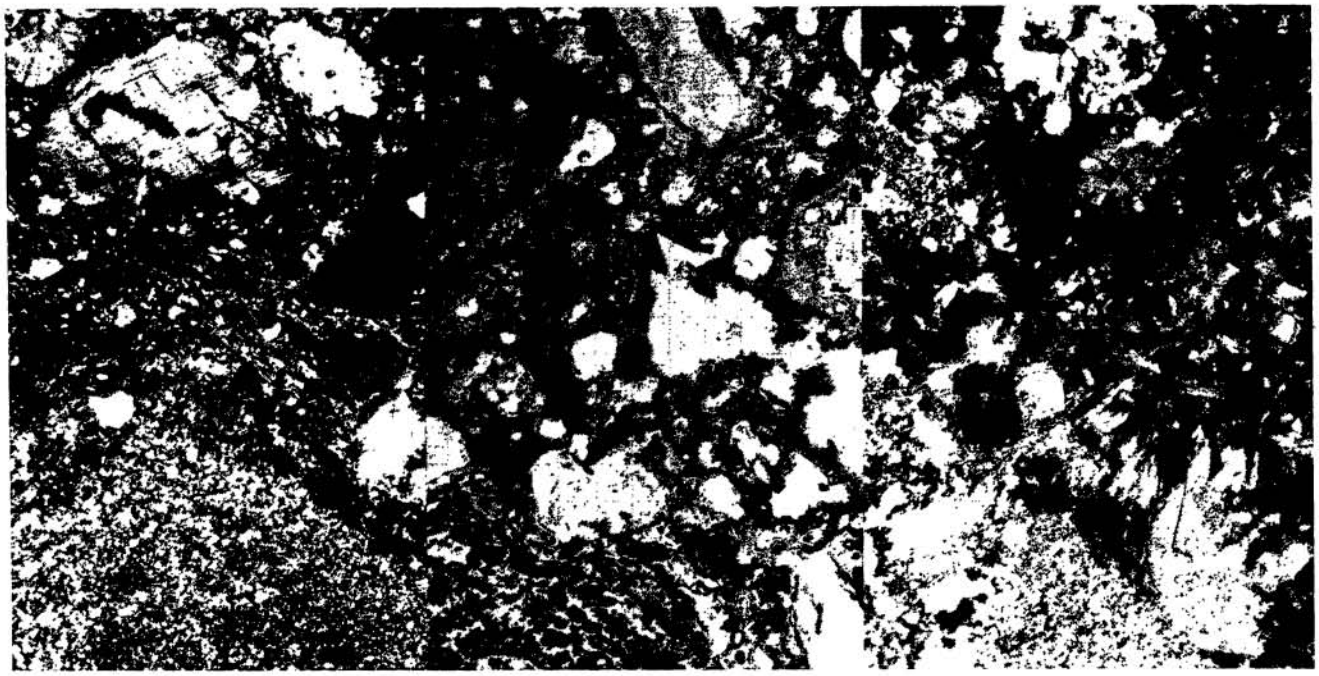

Fig. 2. a) (left) Partially melted clasts in altered matrix, brecciated plagioclase clast on top (sample 9015.5, 3.4 mm wide, crossed polars). **b)** (middle) partially aphanitic impact melt breccia with mostly annealed clasts (sample 9017.6, 3.3 mm wide, parallel polars). **c)** (left) Spherulitically devitrified impact glass (sample 9024.1, 3.4 mm wide, crossed polars).