D'ORBIGNY: A NEW AND UNUSUAL ANGRITE.* G. Kurat [1], F. Brandstätter[1], R. Clayton[2], M. A. Nazarov[3], H. Palme[4], L. Schultz[5], M. E. Varela[6], E. Wäsch[7], H. W. Weber[5] and G. Weckwerth[4]; [1]Naturhistorisches Museum, Postfach 417, A-1014 Vienna, Austria (gero.kurat@univie.ac.at); [2]Enrico Fermi Institute, University of Chicago, Chicago Illinois 60637, USA (r-clayton@uchicago.edu); [3]Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygin Str. 19, Moscow, Russia (nazarov@geokhi.ru); [4] Institut für Mineralogie und Geochemie, Universität zu Köln, D-50674 Köln, Germany; [5]Max-Planck-Institut für Chemie, D-55020 Mainz, Germany (schultz@mpch-mainz.mpg.de); [6]Dept. de Geologia, Universidad Nacional del Sur, 8000 Bahia Blanca, Argentina; [7]Museum für Naturkunde, Humboldt-Universität Berlin, D-10115 Berlin, Germany (elke.waesch@rz.hu-berlin.de).

D'Orbigny was found in July 1979 during ploughing a rock-less field in the south of the Buenos Aires Province, Argentina. Because of its shape it was believed to be an Indian artefact, in particular a mortar, and was kept at the farm. In 2000 a sample was sent to Vienna and identified as angrite. The stone had a mass of 16.55 kg and had a peculiar shape, somewhat like a loaf of bread but with a gently sloped and fusion crust-covered front with regmaglypts and a concave back side. The front and back sides consist of a medium to coarse-grained ophitic textured rock (Fig.1) with a heterogeneous, highly porous coarse-grained rock sandwiched between them (for more details see [1]).

The dense portions of D'Orbigny resembles Asuka 881371 [2-5] and Sahara 99555 [6]. With the latter D'Orbigny shares the presence of abundant round vugs. The major minerals are augite, anorthite and olivine. The augite is rich in Ti, Al and Fe (Tab.1) and chemically zoned to almost Mg-free rims. Augite is also very common in irregularly shaped open druses. There it forms euhedral elongated prismatic crystals and has a chemical composition similar to the cores of rock-forming augites. Anorthite forms laths which commonly include some olivine or augite. It is pure anorthite (Na_2O <0.02 wt%) with minor contents of FeO and MgO. Olivine is very common in the shells of the abundant vugs/hollow spheres (see[1] for more details) and in the medium-grained dense rock portions. It commonly has crystal shapes with rhombic cross-section, similar to augite, and it is zoned from about Fa20 to kirschsteinite. Large (up to cm-sized) olivines are scattered throughout D'Orbigny mimicking xenocrysts or forming olivinite. Their composition is typically Fa9-11.

In places, black glass fills druses and occasionally also spherical vugs (hollow spheres). Its composition is ultrabasic, similar to the angrite bulk composition (for more details see [7]). Minor phases are Cr-bearing Al-rich spinels (commonly associated with olivine and plagioclase), ulvöspinels, a silico-phosphate, FeS, Ni-bearing pyrrhotite, pentlandite and rare Ni-rich metal.

The bulk trace element content (Tab.2) as determined by INAA is rich in refractory lithophile elements which have unfractionated relative abundances (about 10xCI, including Ca), except for Sc which is less abundant than the other refractory elements. Abundances of volatile lithophile and siderophile elements are low.

The concentration and isotopic composition of noble gases as measured following the procedure of [8] are also given in Table 2. The mean exposure age is 11.0 ± 0.8 Ma. The oxygen isotopic composition is: delta^{18}O = +3.5, delta^{17}O = +1.6 ‰.

Discussion: Most parts of D'Orbigny resemble in texture and mineralogy previously described angrites, like Asuka 881371 and Sahara 99555. Also, the mineral compositions are very similar to those in these angrites, as is the oxygen isotope composition. D'Orbigny is the sixth angrite known and it is by far the most massive. Maybe because of its size and certainly because of the generosity of the owner we were able to see and study overall structures not observed before [1]. D'Orbigny is unique in its overall structure, its richness in hollow spheres, the presence of abundant druses containing perfectly crystallized augites and anorthites, the presence of abundant glass [1,7] and the presence of olivinite rocks with olivines of highly magnesian composition (~Fa9), comparable to olivine xenocrysts from Asuka 881371 [3]

The noble gases present in D'Orbigny are very similar to those in other angrites with very high ^{4}He and low ^{40}Ar contents. The mean exposure age of 11.0 ± 0.8 Ma is different from that of all other angrites and falls in between those of LEW 86010 (17.6 Ma) and Asuka 881371 (5.4 Ma) or Sahara 99555 (6.1 Ma) [6, 9]. Possibly, D'Orbigny offers a new window into angrite genesis.

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References: [1] Kurat G. et al., this volume. [2] Yanai K. (1994) Proc. Symp. Antarct. Meteorites 7, 30 – 41. [3] Prinz M. and Weisberg M.K. (1995) NIPR Symp. Antarct.

* In memory of Marty Prinz who had a very close relationship to such rocks but unfortunately could not see this one.

Meteorites 20, 207 – 210. [4] Warren P. and Davis A.M. (1995) NIPR Symp. Antarct. Meteorites 20, 257 – 260. [5] Mikouchi T. et al. (1996) Proc. Symp. Antarct. Meteorites 9, 174 – 188. [6] Bischoff A. et al. (2000) MAPS 35, Suppl. A 27. [7] Varela M.E. et al, this volume. [8] Schultz L. and Weber H. W. (1996) J. Geophys. Res. 101, 21,177–21,181. [9] Eugster O. and Weigel A. (1995) Meteoritics 30, 504.

Table 1:Selected EMP analyses of phases from D'Orbigny (wt%).

	OLIVINE				AUGITE			AN	SI-PH	SPINEL		GLASS
	xeno	groundmass			groundmass		druses			ulvö	Al-sp	CC-1
		core	rim	kir	core	rim	core				core	
SiO_2	41.5	37.0	31.5	31.0	47.6	42.3	46.4	43.7	12.8	0.21	.10	40.8
TiO_2	n.f.	n.f.	0.07	0.04	1.60	4.0	0.53	n.f.	0.73	26.7	0 .22	0.86
Al_2O_3	0.13	0.06	0.07	0.05	7.8	8.1	8.1	34.7	0.23	3.1	58.1	13.3
Cr_2O_3	0.29	0.13	0.12	0.11	0.37	0.05	0.21	n.f.	n.f.	0.06	7.7	0.11
FeO	9.1	34.5	56.2	46.7	12.8	25.6	12.7	0.76	5.0	67.5	21.6	23.3
MnO	0.10	0.45	0.93	0.75	0.21	0.22	0.20	n.f.	0.06	0.35	n.f.	0.27
MgO	49.2	28.8	5.3	1.70	8.8	0.19	9.1	0.27	n.f.	n.f.	14.1	7.7
CaO	0.29	0.85	6.6	20.0	23.2	22.5	22.7	20.3	48.4	0.32	n.f.	14.3
TOT	100.61	101.79	100.79	100.35	102.38	102.96	100.94	99.73	98.92*	98.24	101.82	100.66

n.f.: not found; *) includes 30.7 wt% P_2O_5.

Table 2: INAA and rare gas analyses.

INAA(ppm, % error in parenthesis)												
Na	Ca	Ti	Sc	Cr	Mn	Fe	Co	Ni	Ga	Sr	Zr	La
140(5)	85000	4600(15)	36(3)	300(5)	1600(10)	178000	33(5)	28(20)	0.37(20)	120(20)	50(15)	2.8(8)
Ce	Nd	Sm	Eu	Gd	Dy	Er	Yb	Hf	Au		Th	U
8(8)	6(20)	1.7(5)	0.63(10)	2.3(15)	2(30)	1.7(30)	1.5(5)	1.2(8)	0.0008(15)		0.33(8)	0.08(20)
Rare gases : 10^{-8} cm^3STP/g												
3He	4He	20Ne	21Ne	22Ne	36Ar	38Ar	40Ar					
17.3	14200	2.28	2.31	2.62	1.36	1.99	50					

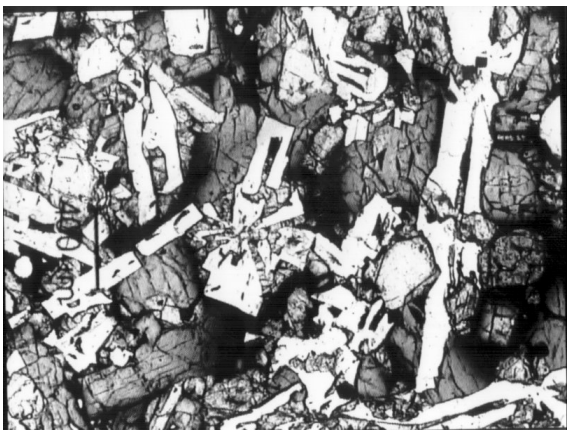

Fig: Dense part of D'Orbigny in transmitted light (anorthite: white; augite: gray; olivine: light gray).