D'ORBIGNY: A NEW WINDOW INTO ANGRITE GENESIS*. G. Kurat[1], M. E. Varela[2], F. Brandstätter[1], E. Wäsch[3] and M. A. Nazarov[4], [1]Naturhistorisches Museum, Postfach 417, A-1014 Vienna, Austria (gero.kurat@univie.ac.at); [2] Dept. de Geologia, Universidad Nacional del Sur, 8000 Bahia Blanca, Argentina (evarela@criba.edu.ar); [3]Museum für Naturkunde, Humboldt-Universität Berlin, D-10115 Berlin, Germany (elke.waesch@rz.hu-berlin.de); [4]Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygin Str. 19, Moscow, Russia (nazarov@geokhi.ru).

Introduction: D'Orbigny, Buenos Aires Province, Argentina, is the sixth and by far the largest angrite known. Its bulk chemical and mineral chemical compositions, rare gas abundances and oxygen and rare gas isotope compositions fit the compositional ranges known from angrites [1]. D'Orbigny, however, is peculiar with respect to three features: the abundance of shelled hollow spheres, the presence of abundant open druses and the abundant presence of glasses [1, 2]. Thanks to the co-operation of the owner of D'Orbigny we had the opportunity to investigate in detail and in an unusual way this unusual rock. Here is a brief preliminary report.

Shape of the stone: D'Orbigny, as it was found, had a somewhat unusual shape (Fig.1). As a typical oriented-flight stone it had a front shield (~ 35 cm long) which gently sloped from the stagnation center and which was covered by regmaglypts and a dark brown fusion crust. The back side had a much smaller diameter (~ 20 cm) and consisted of a concave, round, pan-like indentation with a marked large (2 cm) and several smaller, round open vugs. It was also covered by fusion crust, much less than the front side, and had also less developed regmaglypts. The front and back shields were curved in a semi-parallel way and were intergrown on one side with the opposite side opening like a clam. The space between the plates was filled by a highly porous lithology, very rich in open druses and hollow spheres, partly filled by caliche.

Textures and structure: In an attempt to avoid too much contamination we decided to part the meteorite by breaking. Hammer with or without chisel turned out not to be suitable because the porous portion of the rock was physically week and tended to crumble. Consequently, the parting was done with a heavy hydraulic press, the smaller parting with a laboratory hydraulic press.

The front and back shield lithology is a dense, medium to coarse–grained, sub-ophitic basaltic rock (see Fig. in [1]. It consists mainly of anorthite, augite and olivine. Anorthite forms hollow and hopper – like plates which enclose olivine and augite and which are intergrown with olivine and partly enclosed by large augite crystals. Olivine and augite are compositionally zoned from Fo20 to kirschsteinite and from En27Fs22Wo51 to En1Fs47Wo53, respectively [1]. This shield lithology contains also occasional hollow spheres ("vugs", see below), small, almost closed druses with augite and anorthite crystals and some large (cm) olivine xenocrysts(?).

The hollow spheres are unevenly distributed throughout D'Orbigny, present in all parts, but most common in the porous inner portion. They are between a few mm and 2.5 cm in diameter. The shell is a dense granular intergrowth of fine-grained anorthite and olivine with occasionally some augite at the outside (Fig. 2). The grains tend to be oriented perpendicular to the surface. The inner side of the shell is fairly smooth but has a roughness suggestive of replicating a former solid filling with granular texture (shell fills former indentations at grain boundaries, see Fig.1 in [2]). The surface is commonly lined with a thin cover of sulphides.

Druses are omnipresent in the porous portion of D'Orbigny. They are irregular, open spaces up to 3+ cm in elongation into which perfectly crystallized augites of prismatic habit and anorthite plates protrude. Druses border to walls consisting of a coarse-grained, porous, ophitic basaltic rock rich in anorthite and augite and poor in olivine. Druses commonly also border to shells of hollow spheres with the protruding crystals originating at the shell's surface (Fig.3).

The porous part of D'Orbigny contains many large olivine crystals and also some polycrystalline olivinite (Fig.5). The shapes of these olivinites are very complex and rather suggestive of irregular pore space than of fragmental shapes. Also common in the porous part are glasses filling in part druse space, interstitial space between olivine, augite, or anorthite grains and filling former hollow spheres [2].

Discussion and conclusion: The shape of D'Orbigny, its structure with highly porous lithologies alternating with denser ones and its mineralogical heterogeneity strongly suggest that the rock was not formed by a simple crystallisation of a basaltic melt. The mushroom – like aspect of D'Orbigny and the alternating texturally different layers are suggestive of a directional growth structure rather than of an igneous or metamorphic rock fragment. The abundantly present druses give clear evidence for a pneumatolytic process and the gradations from druses to less porous, coarse-grained, ophitic basaltic rock suggest growth of the whole entity under similar conditions. The hollow spheres appear to be the oldest building unit. Solid spheres of unknown composition (we may speculate on CaS or nitrides) were covered by anorthite + olivine at the earliest stage of rock formation. The solid core of the spheres was subsequently lost. It is possible that this phase became unstable, presumably during the late, highly oxidizing event that created

* In memory of Marty Prinz who was supposed to provide us with his expertise but was not permitted to do so.

the Fe-augite and kirschsteinite rims. The decomposing phase may also have supplied the Ca necessary for the formation of kirschsteinite. The latest event appears to have been the precipitation of glasses into some of the open pore spaces. The origin of the glass and the fact that some spaces were filled, but others not, remains a mystery, as does the origin of olivinite, which likely was formed at an early developing stage, before the very strong Fe-Ca metasomatism occurred. Plenty of work remains to be done.

References: [1] Kurat G et al., this volume; [2] Varela M.E et al., this volume.

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Fig.1: Photograph (a) and drawing (b) of D'Orbigny with the pan-like back shield up. Note the mushroom-like shape. Length is 35 cm

(a)

(b)

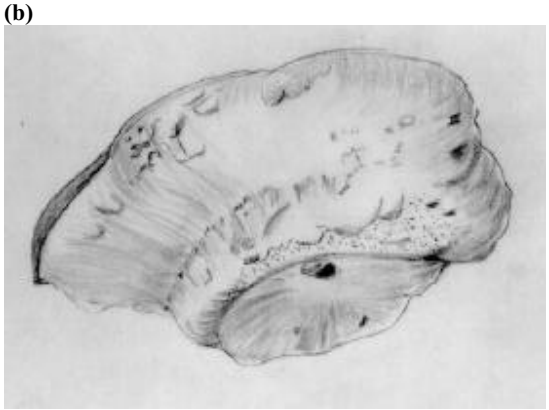

Fig.2: Cut through the shell of a hollow sphere; anorthite is white, olivine is yellow, augite is dark brown.

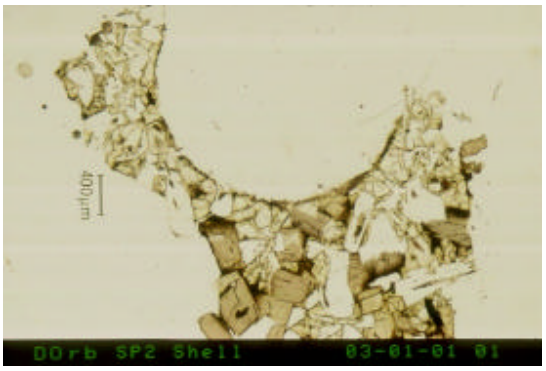

Fig.3: The bottom of a shell (granular) with druse augite crystals on top and bottom.

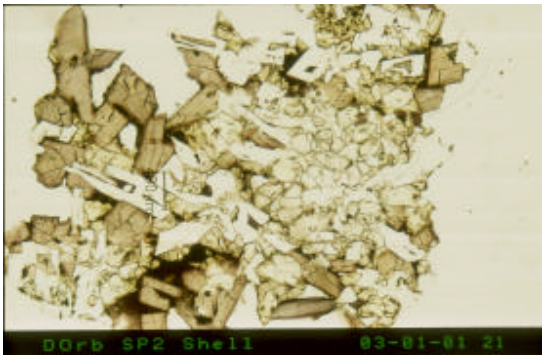

Fig.4: The largest olivinite encountered in D'Orbigny. Note the peculiar shape. (length is 3.7 cm).