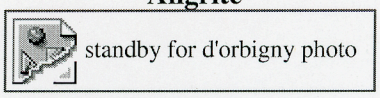
D'ORBIGNY

Angrite



Found July 1979
37° 40' S., 61° 39' W.

This fresh, 16.55 kg, regmaglypted, shield-shaped, meteorite is by far the largest of the six angrites found so far. The mass was found in Buenos Aires, Argentina by a farmworker who hit it with a plow. Thinking he had unearthed an old mortar, he gave it to the landowner who set it by his house for the next several years. Not until 1998, after reading an article on meteorites, did the owner seek to have the stone analyzed. In September of 2000, Dr. Gero Kurat of the Naturhistorisches Museum of Vienna, Austria made the determination that it was an angrite.

D'Orbigny is a basaltic rock that shows no evidence of brecciation or shock metamorphism. It consists predominantly of anorthitic plagioclase, along with strongly zoned grains of fassaite and Ca-rich olivine, plus kirschsteinite. An Fe-containing spinel occurs within some fassaite and anorthite grains, and ulvöspinel, troilite, silico-phosphate, and an unidentified Fe-Ca-Al-Ti silicate, are present in the mesostasis. Rare, cm-sized aggregates, possibly xenocrysts, of magnesian olivine having granoblastic textures are present, similar to those found in other angrites. D'Orbigny contains porous areas containing abundant round vugs up to 2.5 cm, and druses with augite, anorthite, and olivine crystals. The vugs were originally solid spheres but the core was subsequently lost. The elemental abundances of D'Orbigny are similar to other angrites, but it has the lowest CrO content by far.

Previous studies have shown that the close textural and compositional trends present in the angrites Sahara 99555, Asuka 881371, and LEW 87051, are evidence for their crystallization from a common magma source. Trace element data also confirm a similar crystallization history for D'Orbigny. However, LEW 86010 shows evidence of slower cooling than the above and is probably not co-magmatic. Angra dos Reis is very different from all other angrites. A two-stage cooling history is indicated for D'Orbigny by the sharply zoned, core/rim boundaries within olivine grains, while a more gradual zoning profile is evident in the fassaite grains.

- **Crystallization of the angrites proceeded as a two-stage process beginning with partial melting from a source composed of olivine, orthopyroxene, and clinopyroxene at low pressure, followed by slow cooling to ~650°C when it was rapidly quenched (1-50°C/hr) during a severe impact event.**
- **Severe outgassing of volatiles occurred at this time, possibly hastened by the reduced strength of the gravitational field of the fragmented asteroid.**
- **Based on studies of how kirschsteinite lamellae profiles relate to cooling rates as well as results of crystallization experiments, the burial depth of the angrites as they rapidly crystallized in a thin lava flow is inferred to have been within 1 m of the surface.**

Angrites are extremely ancient meteorites, with absolute ages comparable to the CAIs found in Allende, having been formed only 3 m.y. after these first nebular condensates. Extensive isotopic studies establish angrites as an early planetary differentiate undisturbed since formation 4.53 b.y. ago. Its decay products of extinct radionuclides suggest the entire sequence from nebular condensation through parent body accretion, partial melting of the parent body, core formation, formation of olivine and fassaite rock, cumulate/crystallization processes, and final cooling to temperatures low enough to retain fission tracks and noble gases, took an incredibly short 18 m.y. A comparison of cosmic-ray exposure ages shows that while Sah 99555 (6.1 ±0.2 m.y.) and Asuka 881371 (5.4 ±0.7 m.y.) are similar within uncertainties, each of the other angrites represents a unique ejection event on the parent body. Cosmic-ray exposure data for D'Orbigny has not yet been published.

The three Antarctic angrites LEW 86010 (6.9 g), LEW 87051 (0.6 g), and Asuka 881371 (11.2 g), along with Sah 99555 (2,710 g), D'Orbigny (16.55 kg), and the type specimen Angra dos Reis (~150 g of 1.5 kg preserved), comprise our rare sampling of the angrite parent body. Spectral studies of these new angrites, especially D'Orbigny, have yielded two spectral analogs among main-belt asteroids; the A-type 289 Nenetta and the Sr-type 3819 Robinson both show the strong spectral reddening characteristic of the fassaitic-rich angrites. Another recent find from Antarctica, YA 1154, is an anomalous fassaite-rich meteorite compositionally similar to angrites but with a unique fine-grained, dendritic texture. The above specimen of D'Orbigny is an 0.11 g, very thin interior slice.