NWA 776: A HOWARDITE WITH AN ANOMALOUSLY HIGH ABUNDANCE OF CARBONACEOUS CHONDRITE XENOLITHS. C. A. Lorenz[1], G. Kurat[2] and F. Brandstaetter[2], [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygin Str. 19, 117975 Moscow, Russia, lorentz@geokhi.ru, [2]Naturhistorisches Museum, Postfach 417, A-1014 Vienna, Austria, gero.kurat@univie.ac.at

The NWA 776 howardite was found in 2001, is a very fresh (W0-W1) rock of 43.5 g and is coated by a black glassy fusion crust with aerodynamic flow pattern. It is a dark, unusually compact polymict breccia, consisting of mineral, rock and numerous carbonaceous chondrite clasts embedded into a fine-grained matrix. Melt veins enriched in metal and sulfide cross the sample. Rock clasts vary in size from 20 to 1500 µm and comprise basalt-like rocks, orthopyroxenites, pyroxene-olivine rocks, melt rocks and breccias. Basaltic clasts are medium- to fine-grained, rarely coarse-grained, ophitic to subophitic and minor granular pyroxene-plagioclase rocks. Orthopyroxene is $En_{31-50}Wo_{2-5}$ with lamellae of clinopyroxene $En_{28-48}Wo_{33-50}$. Average feldspar is $An_{85.4}$. The minor phases are silica, troilite, chromite, ilmenite, Ca-phosphate and metal. Several clasts of augite-dominated basalts are present. They consist of augite $En_{31-33}Wo_{43-45}$ with lamellae of low-Ca pyroxene $En_{37.5-39.5}Wo_{2.7-4.4}$ and feldspar $An_{87.7-92.5}$. One clast of iron-rich basalt was found. It is a medium-grained granular rock consisting of pyroxene $En_{11.2}Wo_{44.3}$ and feldspar $An_{83.9}$. Fine-grained symplectite-like aggregates of olivine $Fa_{75.4}$ and silica, associated with troilite, are located in clinopyroxene.

Pyroxenites are present as rare medium-grained fragments of 100 - 300 µm size and consist of orthopyroxene En_{70-83} with minor feldspar An_{92}, olivine Fo_{73-92} and chromite. Several clasts consist of orthopyroxene $En_{70-78}Wo_{1-3}$ and olivine Fo_{70-75} with minor chromite and could be fragments of coarse-grained olivine pyroxenites.

Fine-grained melt rocks are present as 20 - 100 µm clasts of pyroxene-plagioclase and pyroxene-olivine rocks. Pyroxene-plagioclase rocks have a fine-grained graphic texture of approximately equal amounts of pyroxene and plagioclase. Rare fine-grained pyroxene and pyroxene-olivine rocks consist of euhedral, slightly zoned pyroxene $En_{69-79}Wo_{2.8-10.4}$ and olivine $Fo_{73.7}$ in a microcrystalline mesostasis.

Breccias are rare components of NWA 776. They comprise two rock types. First, clast matrix breccias with extremely fine-grained matrix and consisting of rock and mineral fragments of basalts and pyroxenites. Secondly, melt matrix breccias with microcrystalline or glassy matrices.

Only one glass particle was found in the section available. It is a 100 µm-sized complete glass drop with gas bubbles placed along the margins. The glass contains pyroxene phenocrysts $En_{40.6}Wo_{7.1}$, $En_{30.0}Wo_{43.9}$ and tiny droplets of chromite.

Mineral fragments vary in size from 20 to 800 µm and comprise pyroxene $En_{33-86}Wo_{1-46}$, plagioclase An_{62-94}, silica, olivine $Fo_{73.9-79.8}$, troilite, chromite, ilmenite, rutile and metal. Two clasts with unusually coarse (20 - 50 µm) augite lamellae were found. Several clasts ($En_{42.2-35.2}Wo_{2.4-19.2}$) contain veinlet-like fayalite $Fa_{77.7}$. The low-Ni (1 - 2 wt.%) metal fragments usually contain silica and pyroxene fragments. Aggregates of intergrown low-Ni metal and eucritic silicates are also present.

The abundance of carbonaceous chondrite (CC) clasts in NWA 776 is unusually high compared to known howardites. We count about 105 clasts on 85 mm^2. The CC clasts vary in size from 5 to 1500 µm. Fragments less then 5 µm are squeezed between mineral clasts and are visible as flake-like particles of phyllosilicates or separated magnetite spherules. Isolated clasts of forsterite $Fo_{98.5}$ are also present in the howardite matrix. One anorthite $An_{91.7}$ grain with a magnetite-rimmed pure forsterite $Fo_{98.6}$ in the center found among howardite material could also be related to CC clasts. Some CC fragments are rounded and display sharp boundaries with the host howardite.

The carbonaceous chondrite clasts can be classified into three types by texture and composition of silicate grains and matrix. CC clasts are similar in composition and in abundance of silicate grains.

The first type (22 clasts) consists of clasts with 80 vol% matrix with embedded grains and angular clasts of olivine $Fo_{97.4-99.6}$, minor pyroxene $En_{97}Wo_{0.5}$, Fe- and Fe-Ni sulfides and magnetite spherules and aggregates thereof (Fig. 2).

The second type (41 clasts) consists of clasts with 50 vol% matrix and 20 - 50µm-sized grains and aggregates of forsterite, minor enstatite, flakes or granular aggregates of phyllosilicates, calcium carbonate, minor troilite, rare P-Cr-Fe-Ni-sulphide, kamacite (5 wt% Ni), schreibersite (25 - 44 wt% Ni) and spinel (9.4 wt% Cr_2O_3) (Fig. 3). Some olivines contain inclusions of metal and spinel. The inhomogeneous matrix consists of patches of oxide- and sulfide-rich areas. Thin veins filled by FeO-rich phases cross aggregates of phyllosilicate grains. A phyllosilicate aggregate (in clast N10) has an interstitial magnesium-aluminum-rich material (in wt%): Na2O 0.11; MgO 31.7; Al2O3 15.2; SiO2 42.3; K2O 0.30; CaO 0.97; TiO2 0.05; Cr2O3 0.17; MnO 0.18; FeO 7.2; NiO 0.90.

The third type (6 clasts) comprises clasts of 10 - 50 µm size, consisting of a fine-grained (1 - 5 µm) mix of matrix material with forsterite clasts, sulfide and magnetite. The position of this group among the netite. The position of this group among the classified carbonaceous chondrites is unclear (Fig. 4).

The 36 clasts are unclear for classification due their small sizes.

Discussion: The compositions of rock and mineral fragments of NWA 776 are similar to those of other howardites. Bulk compositions of the fine-grained melt rocks and melt breccias are close to that of howardites and eucrites and could have been formed by remelting of previous breccia generations. Only a few of them have unusually high CaO contents (up to 14.5 wt%). The compositions of pyroxene fragments are similar to that of rock clasts with exception of those which close the gap between "eucritic" and "diogenitic" composition. The origin of these pyroxene is not clear.

Unusually high abundance of CC xenoliths distinguishes NWA 776 from other howardite breccias. The structure and composition of first and second groups of carbonaceous chondrite clasts are close to that founded in the carbonaceous chondrite meteorites. The third group is unusual by structure compare to other carbonaceous chondrites. The fact that these xenoliths are free of shock features and occur as clasts of different sizes, types and textures indicates that they are not fragments of several bigger pieces but rather individual micrometeorites. The regular distribution of CC clasts within the breccia could reflect their incorporation simultaneously with the assembly of the howardite. The NWA 776 howardite collected CC dust during its formation that was available in the formation region. The dust is comparable in size and composition to that of interplanetary dust collected by the Earth today [1]. The different proportion of rock types in NWA 776 as compared to Antarctic ice could reflect inhomogeneity of dust distribution in space and time.

References: [1] Kurat, G. et al. (1994) GCA 58, 3879-3904.

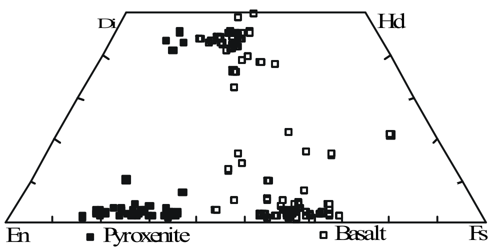

Fig. 1. The composition of pyroxenes from basalt and pyroxenite rock clasts in NWA 776.

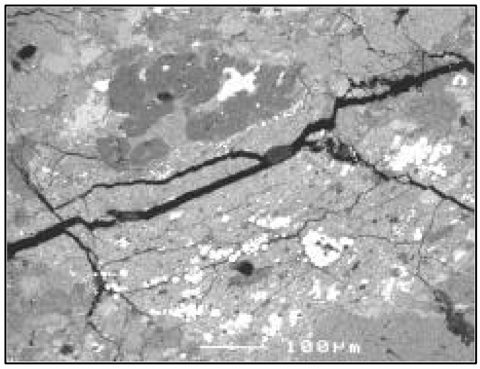

Fig. 2. BSE of clast of first type with forsterite (dark grey) and magnetite (white) in fine-grained phyllosilicate matrix.

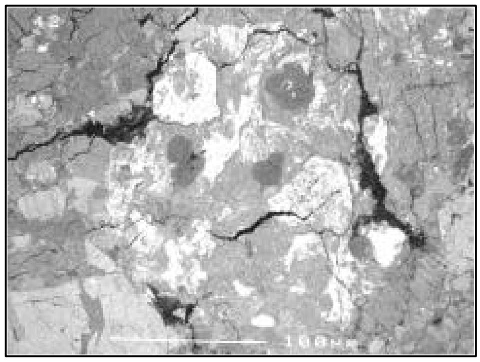

Fig. 3. BSE of clast of second type with forsterite (dark grey) and Fe-rich phyllosilicates (light-grey) in phyllosilicate matrix.

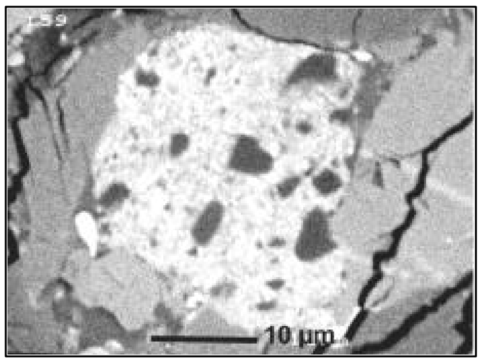

Fig. 4. BSE of a non-classified CC clast (third type). Silicates (dark grey) are embedded into sulfide-rich phyllosilicate matrix.

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