DHOFAR 732: A MG-RICH ORTHOPYROXENITIC ACHONDRITE. S. I. Demidova[1], M. A. Nazarov[1], G. Kurat[2], F. Brandstätter[2], T. Ntaflos[3], R. N. Clayton[4] and T. K. Mayeda[4] [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygin St. 19, Moscow 119991, Russia, demidova@geokhi.ru; [2]Naturhistorisches Museum, A-1014 Vienna, Austria; [3]Univ. Wien - Geozentrum, Department of Geological Sciences, Althanstr. 14, A-1090 Vienna, Austria; [4]Enrico Fermi Institute, Univ. of Chicago, Chicago IL 60637

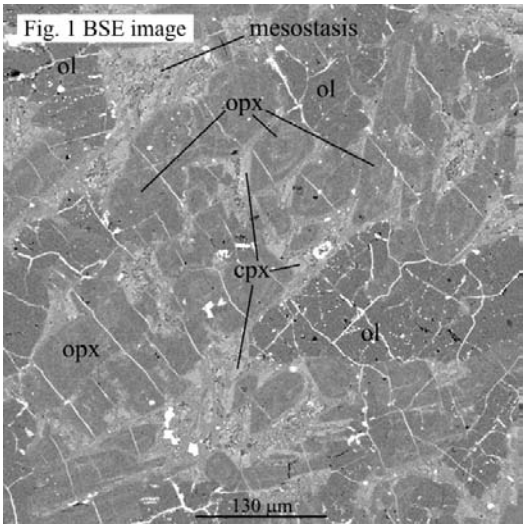
Introduction: Dhofar 732 is an ungrouped achondrite found in Oman. We report here preliminary data on the petrography, mineralogy, chemistry and oxygen isotopic composition of this meteorite, which is completely different from any known achondrite.

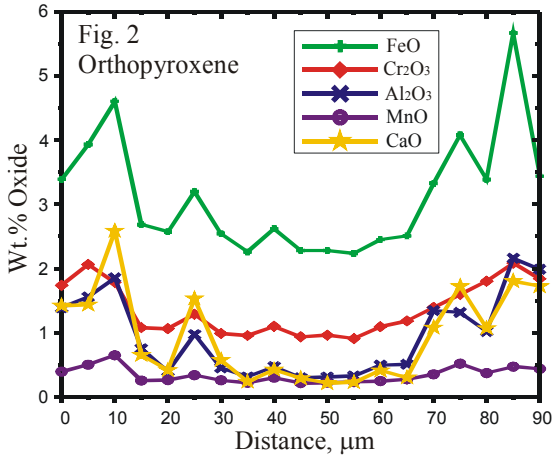
Results: Dho 732, weighing 17g, is a coarse-grained rock, that consists of lath-shaped euhedral orthopyroxenes up to 0.8 mm in size (68 vol.%), rounded olivine grains up to 0.3 mm in size (16 vol.%) and mesostasis (16 vol.%). The mesostasis consists of a Ca, Al-rich, Na-poor glass (8 vol.%) plus crystallites of Cr, Al-rich clinopyroxene (7 vol.%) and silica (1 vol.%). There are abundant round voids (7 vol%) in the rock.

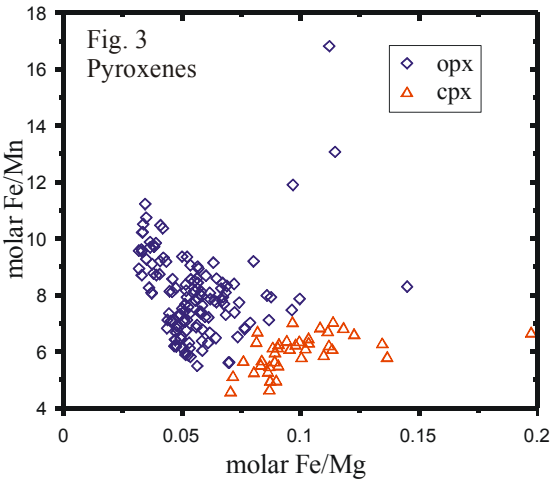
Texturally, Dho 732 is similar to an igneous cumulate rock (Fig. 1). Orthopyroxene is enstatite ($Wo_{0.4-7}En_{82-97}$), which has high Cr_2O_3 and Al_2O_3 contents (0.9-2.9 and 0.3-4.6 wt.%, respectively) and shows oscillatory zoning (Figs. 1, 2). No polysynthetic twinning typical for inverted clinoenstatite was observed. Clinopyroxene - augite ($Wo_{26-40}En_{54-65}$) overgrowth orthopyroxene at the contact with the mesostasis. It is rich in Cr_2O_3 (1.7-3.3 wt.%) and has high Al_2O_3 (2.5-7.5 wt.%), and TiO_2 (0.7-1.5 wt.%) contents. The Fe/Mg and Fe/Mn ratios of the pyroxenes are anti-correlated (Fig.3). Olivine (Fo_{91-95}) is enriched in Cr_2O_3 (0.6-1.2 wt.%) and CaO (0.15-0.33 wt.%) and slightly zoned in Fe, Cr, Ca. Accessory minerals are Ti-poor, Mg, Al-rich chromite, troilite and Fe-Ni metal (1.6-8.1 wt.% Ni; 0.3-0.6 wt.% Co). Occasionally, tiny troilite inclusions form trails in olivines. Mg, Al-chromite was found in one olivine but commonly it is present in the mesostasis as small euhedral crystals. The average mesostasis glass composition is (wt.%): 48.3 SiO_2; 0.1 TiO_2; 31.0 Al_2O_3; 0.06 Cr_2O_3; 0.6 FeO; 0.06 MnO; 1.1 MgO; 18.2 CaO; 0.4 Na_2O; 0,02 K_2O. The mesostasis is poor in Na.

The stone is moderately weathered. There are abundant Fe hydroxides in cracks and some voids. The hydroxides form also fine-grained intergrowths with a Ni,Fe-sulfide. Terrestrial gypsum, calcite and Ca phosphate are also present.

The oxygen isotope composition, $\delta^{17}O$=+2.77, $\delta^{18}O$=+6.64, indicates possible relation of the meteorite with silicate inclusions from IAB irons, winonaites, ureilites and CR chondrites [1, 2].





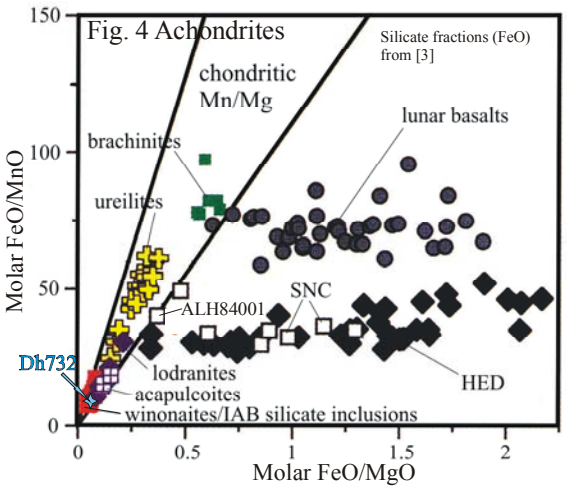


The bulk composition of Dho 732 was computed from mineral modes and mineral chemistries, which were measured in a polished thin section of 19×11 mm in size. This composition is (wt.%): 54.0 SiO_2; 0.22 TiO_2; 3.91 Al_2O_3; 1.49 Cr_2O_3; 3.55 FeO; 0.41 MnO; 33.5 MgO; 3.65 CaO; 0.04 Na_2O; <0,01 K_2O. Trace elements were determined by INAA on a 20 mg chip. The meteorite has a very high MG# (94) and an extremely low Fe/Mn ratio (~9). Similar to ureilites, Dho 732 is enriched in the lithophile elements Sc, Mg, Cr and Mn (generally up to 2-3×CI) and depleted in Na (0.1×CI), Ni and Co (~0.1×CI) and it has a slightly superchondritic Ca/Al ratio. The REE pattern (~4-7×CI) shows a small enrichment in LREEs. The relatively high Ba and Sr concentrations (242 and 337 ppm, respectively) point to a moderate terrestrial contamination.

Discussion: Based on mineralogical, chemical and oxygen isotopic compositions Dho 732 can not be assigned to any known group of meteorites. Petrographically, it should be classified as an olivine orthopyroxenite. The known meteoritic orthopyroxenites are aubrites, diogenites and the SNC meteorite ALH84001, which are all different from Dho 732. Aubrites consist of enstatite [10], whereas diogenites have a significantly lower MG#, a higher Fe/Mn ratio and a very different oxygen isotopic composition [1,6]. The same holds for ALH84001 [5].

Very low FeO/MgO and FeO/MnO ratios clearly distinguish Dho 732 from known achondritic meteorites; similar values were documented only in silicate inclusions from IAB irons, winonaites and lodranites [3] (Fig. 4). Winonaites and IAB silicate inclusions are also close to Dho 732 in oxygen isotopic composition. However, the low Na content of the mesostasis distinguishes Dho 732 from these rocks, as well as from acapulcoites, aubrites, brachinites and ureilites, which contain either sodic plagioclase or a Na-rich mesostasis [e.g., 7]. In oxygen isotopic composition and Cr content of mafic phases Dho 732 is most similar to ureilites [1,4]. However, in contrast to ureilites Dho 732 contains no carbon phases and it has abundant Na-poor mesostasis. In addition, Dho 732 doesn't show any visible reduction features typical for ureilites.

The texture of Dho 732 suggests that the rock has been crystallized from a melt and could be a cumulate. The observed crystallization sequence is simple (olivine → orthopyroxene → augite + Ca, Al rich melt) and consistent with that predicted by model calculations. If the rock is a cumulate, its composition does not represent the parent melt composition. The parent melt must have a lower MG# and be rich in Ca and Al. However, the parent melt cannot be originated from a chondritic source. As compared to chondrites, the source of the Dho 732 parent melt should be depleted in FeNi metal, enriched in Ca/Al and MG#, and depleted in Na. A melt equilibrated with the Dho 732 olivine should have a MG# of about 88 that is too high for a chondrite source. A possible source of the Dho 732 melt could be a parent body formed by accretion of so called isolated forsterite and enstatite grains described in CM chondrites and aggregates and chondrules from CR chondrites [e.g., 8,9]. The objects are rich in MG#, have low Fe/Mn and have high Ca and Cr contents. CR chondrites have similar oxygen isotopic composition [2].



Summary: Dho 732 is a high-MG# meteoritic orthopyroxenite with unique oxygen isotopic composition. The rock was formed from a melt but the melt cannot be simply related with any known meteorite groups. However Dho 732 may have relationships with ureilites and CR chondrules and aggregates.

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